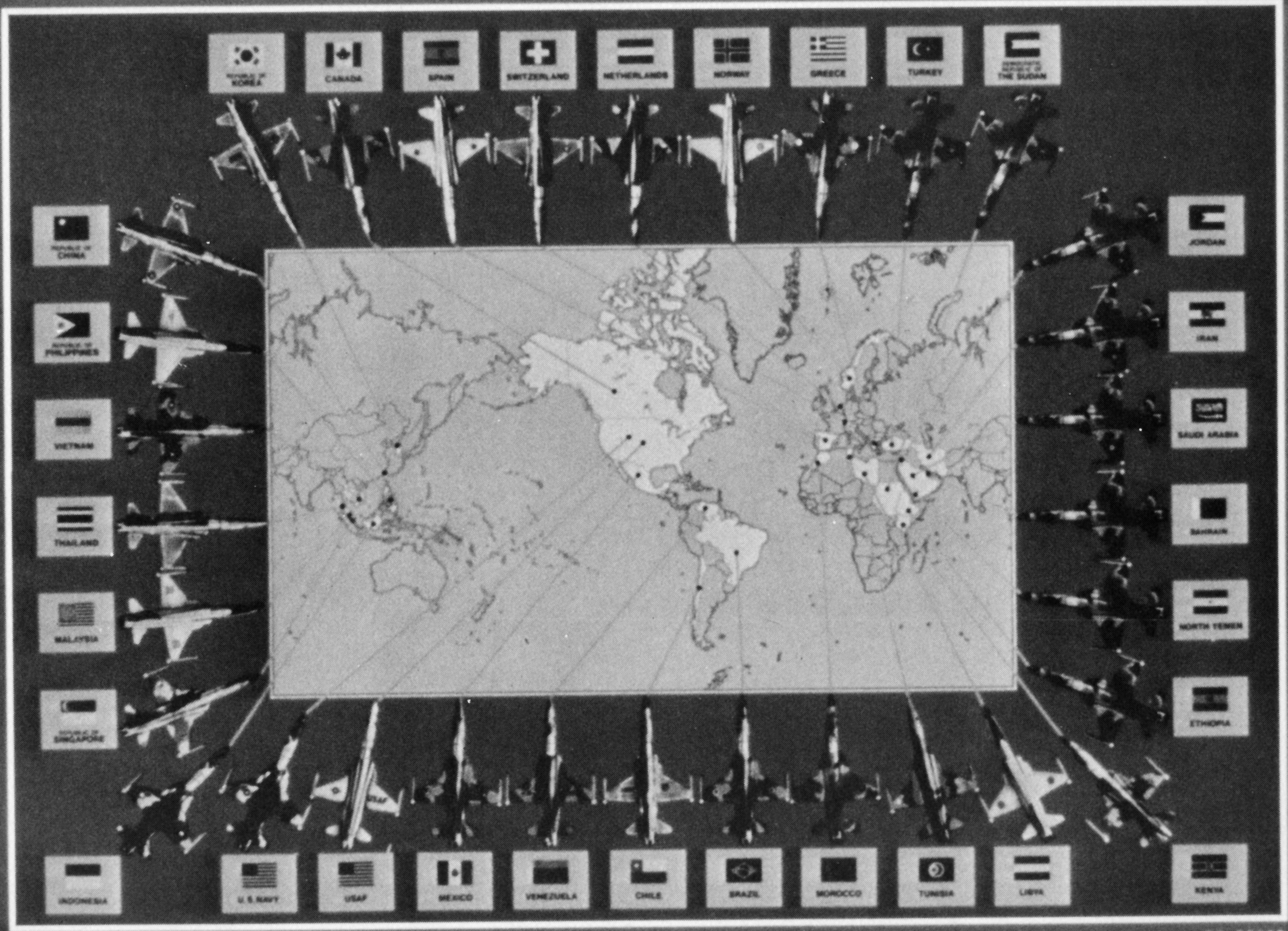
NB 86-89
REVISED
MAY 1986

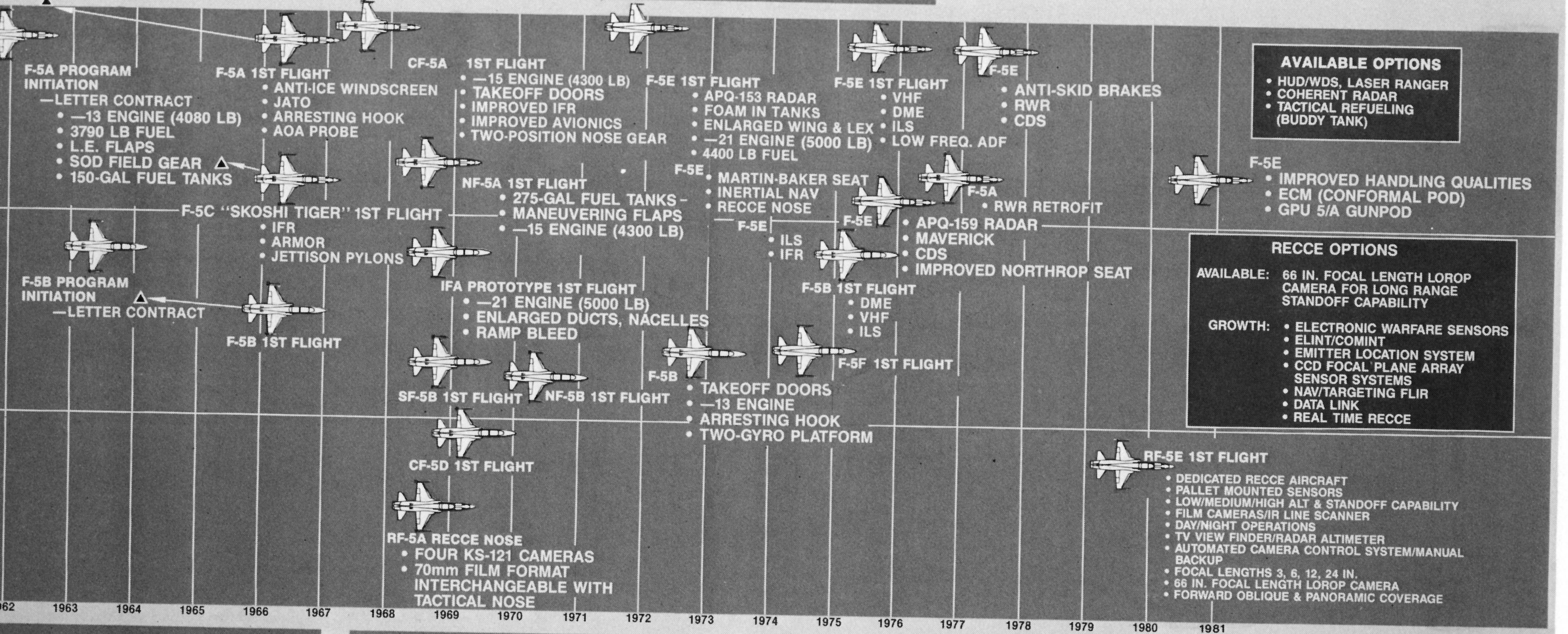
F-5E/F ENHANCEMENTS

F-5 Worldwide Deployment


REPUBLIC OF KOREA
CANADA
SPAIN
SWITZERLAND
NETHERLANDS
NORWAY
GREECE
TURKEY
DEMOCRATIC REPUBLIC OF THE SUDAN
REPUBLIC OF CHINA
REPUBLIC OF PHILIPPINES
VIETNAM
THAILAND
MALAYSIA
REPUBLIC OF SINGAPORE
JORDAN
IRAN
SAUDI ARABIA
BAHRAIN
NORTH YEMEN
ETHIOPIA
INDONESIA
U.S. NAVY
USAF
MEXICO
VENEZUELA
CHILE
BRAZIL
MOROCCO
TUNISIA
LIBYA
KENYA
USAF

85-00653

F-5 HISTORY OF GROWTH



F-5A PROGRAM INITIATION
—LETTER CONTRACT
- —13 ENGINE (4080 LB)
- 3790 LB FUEL
- L.E. FLAPS
- SOD FIELD GEAR
- 150-GAL FUEL TANKS

F-5A 1ST FLIGHT
- ANTI-ICE WINDSCREEN
- JATO
- ARRESTING HOOK
- AOA PROBE

F-5C "SKOSHI TIGER" 1ST FLIGHT
- IFR
- ARMOR
- JETTISON PYLONS

F-5B PROGRAM INITIATION
—LETTER CONTRACT

F-5B 1ST FLIGHT

CF-5A 1ST FLIGHT
- —15 ENGINE (4300 LB)
- TAKEOFF DOORS
- IMPROVED IFR
- IMPROVED AVIONICS
- TWO-POSITION NOSE GEAR

NF-5A 1ST FLIGHT
- 275-GAL FUEL TANKS
- MANEUVERING FLAPS
- —15 ENGINE (4300 LB)

IFA PROTOTYPE 1ST FLIGHT
- —21 ENGINE (5000 LB)
- ENLARGED DUCTS, NACELLES
- RAMP BLEED

SF-5B 1ST FLIGHT

NF-5B 1ST FLIGHT

CF-5D 1ST FLIGHT

RF-5A RECCE NOSE
- FOUR KS-121 CAMERAS
- 70mm FILM FORMAT INTERCHANGEABLE WITH TACTICAL NOSE

F-5E 1ST FLIGHT
- APQ-153 RADAR
- FOAM IN TANKS
- ENLARGED WING & LEX
- —21 ENGINE (5000 LB)
- 4400 LB FUEL

F-5E
- MARTIN-BAKER SEAT
- INERTIAL NAV
- RECCE NOSE

F-5E
- ILS
- IFR

F-5B
- TAKEOFF DOORS
- —13 ENGINE
- ARRESTING HOOK
- TWO-GYRO PLATFORM

F-5E 1ST FLIGHT
- VHF
- DME
- ILS
- LOW FREQ. ADF

F-5E
- APQ-159 RADAR
- MAVERICK
- CDS
- IMPROVED NORTHROP SEAT

F-5B 1ST FLIGHT
- DME
- VHF
- ILS

F-5F 1ST FLIGHT

F-5E
- ANTI-SKID BRAKES
- RWR
- CDS

F-5A
- RWR RETROFIT

F-5E
- IMPROVED HANDLING QUALITIES
- ECM (CONFORMAL POD)
- GPU 5/A GUNPOD

AVAILABLE OPTIONS
- HUD/WDS, LASER RANGER
- COHERENT RADAR
- TACTICAL REFUELING (BUDDY TANK)

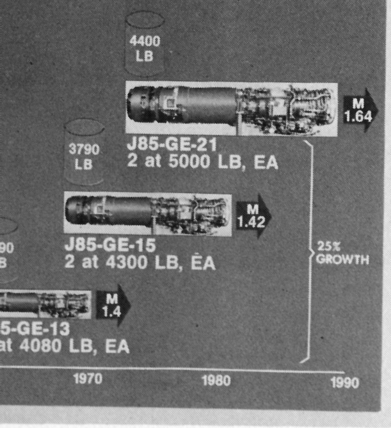
RECCE OPTIONS

AVAILABLE: 66 IN. FOCAL LENGTH LOROP CAMERA FOR LONG RANGE STANDOFF CAPABILITY

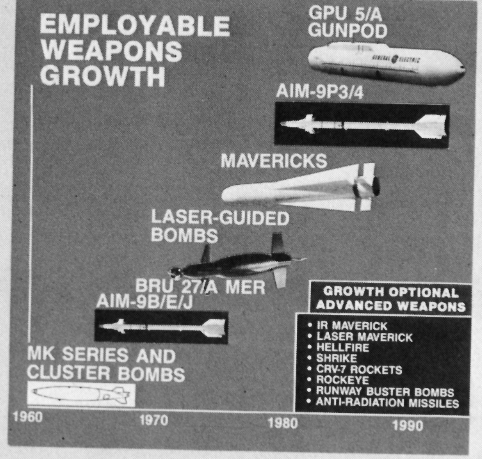
GROWTH:
- ELECTRONIC WARFARE SENSORS
- ELINT/COMINT
- EMITTER LOCATION SYSTEM
- CCD FOCAL PLANE ARRAY SENSOR SYSTEMS
- NAV/TARGETING FLIR
- DATA LINK
- REAL TIME RECCE

RF-5E 1ST FLIGHT
- DEDICATED RECCE AIRCRAFT
- PALLET MOUNTED SENSORS
- LOW/MEDIUM/HIGH ALT & STANDOFF CAPABILITY
- FILM CAMERAS/IR LINE SCANNER
- DAY/NIGHT OPERATIONS
- TV VIEW FINDER/RADAR ALTIMETER
- AUTOMATED CAMERA CONTROL SYSTEM/MANUAL BACKUP
- FOCAL LENGTHS 3, 6, 12, 24 IN.
- 66 IN. FOCAL LENGTH LOROP CAMERA
- FORWARD OBLIQUE & PANORAMIC COVERAGE

OPULSION AND FUEL

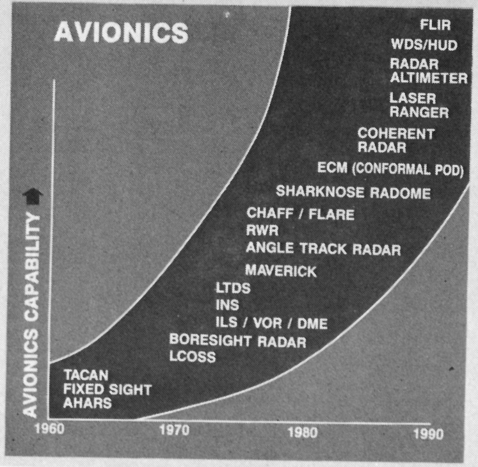


EMPLOYABLE WEAPONS GROWTH

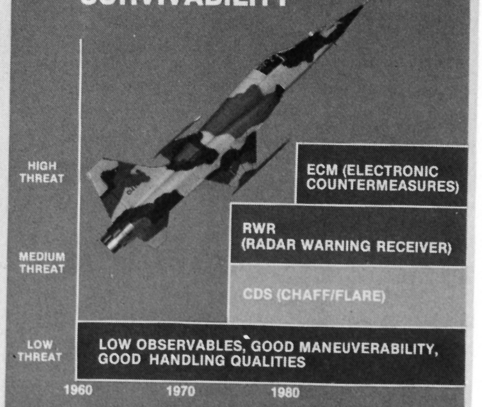


GROWTH OPTIONAL ADVANCED WEAPONS
- IR MAVERICK
- LASER MAVERICK
- HELLFIRE
- SHRIKE
- CRV-7 ROCKETS
- ROCKEYE
- RUNWAY BUSTER BOMBS
- ANTI-RADIATION MISSILES

AVIONICS



SURVIVABILITY



BASIC F-5E CAPABILITIES

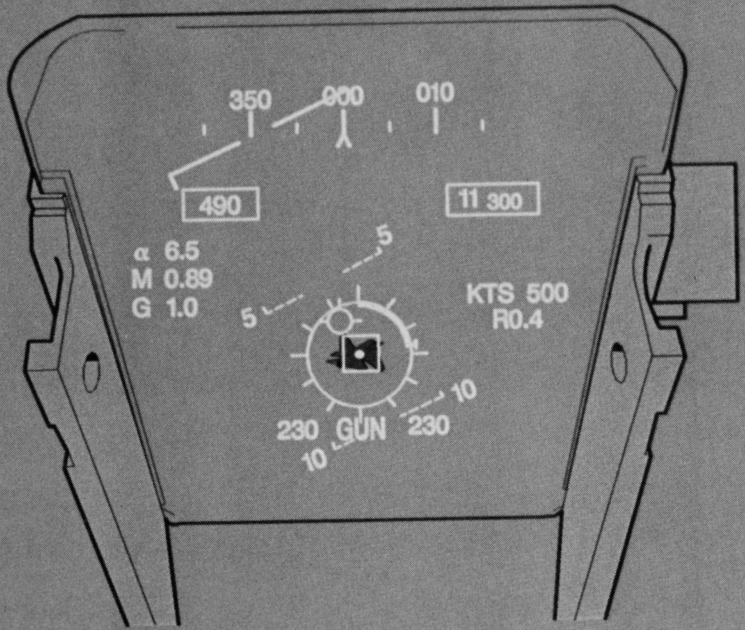
PERFORMANCE, HANDLING	UNRESTRICTED FLIGHT ENVELOPE; SUPERIOR STABILITY, CONTROL, AND HANDLING
AIR-TO-AIR	GUN: ACCURATE SOLUTION FOR MANEUVERING AND NON-MANEUVERING TARGETS IR MISSILE: REAR HEMISPHERE, COMPUTED LAUNCH CUES, BORESIGHT LAUNCH
AIR-TO-GROUND	ROLL-STABILIZED, MANUALLY - DEPRESSIBLE SIGHT RETICLE: WINGS LEVEL "CANNED" BOMBING SOLUTION; BOMBS, ROCKETS, MISSILES
SURVIVABILITY	LOWEST OBSERVABLES, DRY WING, TWIN ENGINES
RELIABILITY, MAINTAINABILITY	LOW MAINTENANCE COST, HIGH AVAILABILITY

EXCELLENT MULTIROLE FIGHTER WITH PROVEN AIR-TO-AIR AND AIR-TO-GROUND CAPABILITIES

Technology Enhancements

- HUD/Weapons Delivery Computer
- HUD/Weapons Delivery Computer/INS
- Laser Ranger
- Multimode Radar
- Defensive Systems
- Weapons
- Air Refueling
- Program Plan
- Summary

HUD/Weapons Delivery Computer Capabilities


350
000
010
490
11 300
α 6.5
M 0.89
G 1.0
5
5
KTS 500
R0.4
10
230
GUN
230
10

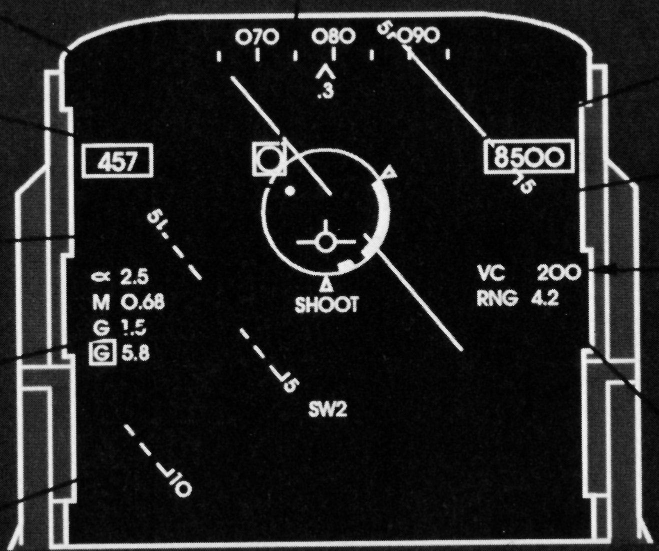
HUD Displays

- Air-to-Air
  - Gun Firing
  - IR Missile Cues
- Air-to-Ground
  - CCIP Mode
  - CCRP Mode

Weapons Computer

- Higher Accuracy Missile/Gun Firing Envelope Computation
- Software Flexibility for New Weapons

HUD DISPLAY FOR ADVANCED IR MISSILE


070
080
090
5
.3
457
8500
15
15
∝ 2.5
M 0.68
G 1.5
G 5.8
SHOOT
VC 200
RNG 4.2
5
SW2
10

TARGET LOCATOR BOX (RADAR LOS)

MISSILE SEEKER CIRCLE (MISSILE FOV)

STEERING DOT

ASE CIRCLE

MAX RANGE

PITCH LADDER

MIN RANGE

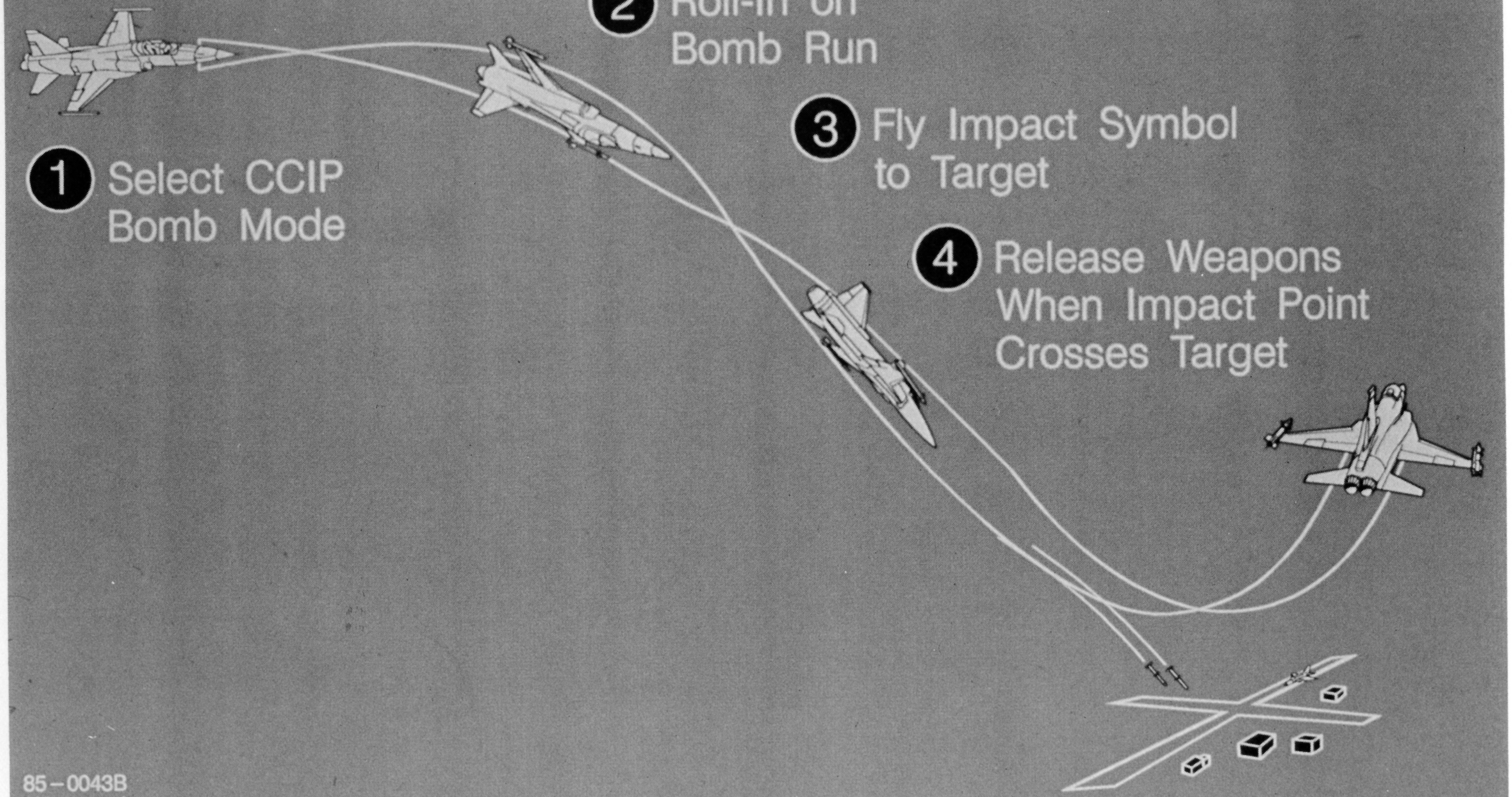
RANGE BAR

TARGET CLOSING VELOCITY

TARGET RANGE

IR MISSILE SELECTED

CCIP Bomb Delivery



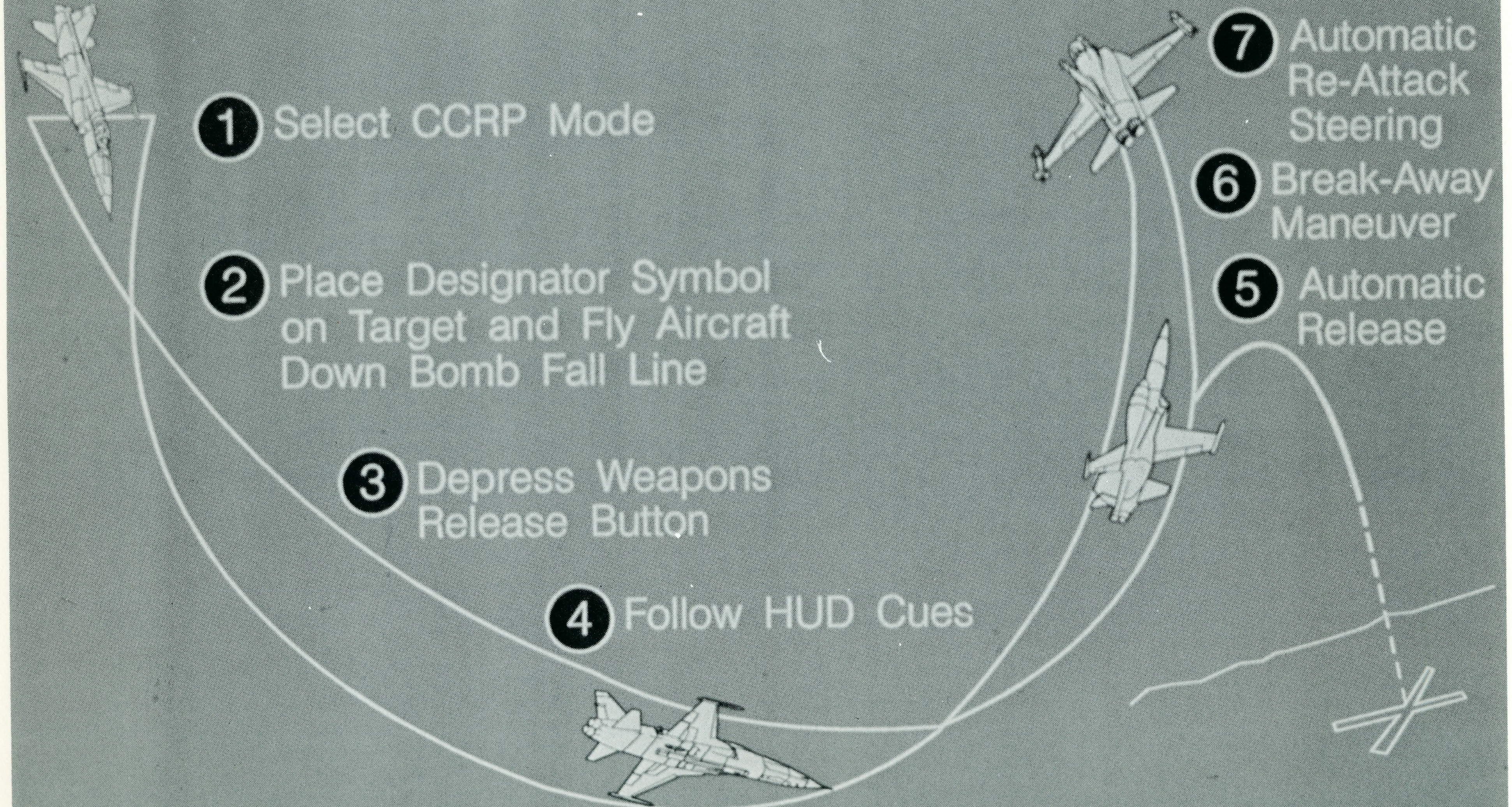
① Select CCIP Bomb Mode

② Roll-In on Bomb Run

③ Fly Impact Symbol to Target

④ Release Weapons When Impact Point Crosses Target

CCRP Dive Toss Delivery



1. Select CCRP Mode
2. Place Designator Symbol on Target and Fly Aircraft Down Bomb Fall Line
3. Depress Weapons Release Button
4. Follow HUD Cues
5. Automatic Release
6. Break-Away Maneuver
7. Automatic Re-Attack Steering

84–5392B
3G II

HUD/WDC

Air-to-Air

- Accurate Missile/Gun Envelope Computation
- Enhanced Attack Data Presentation
- Maximum Pilot/Aircraft Combat Capability
- Software Flexibility for New Weapons

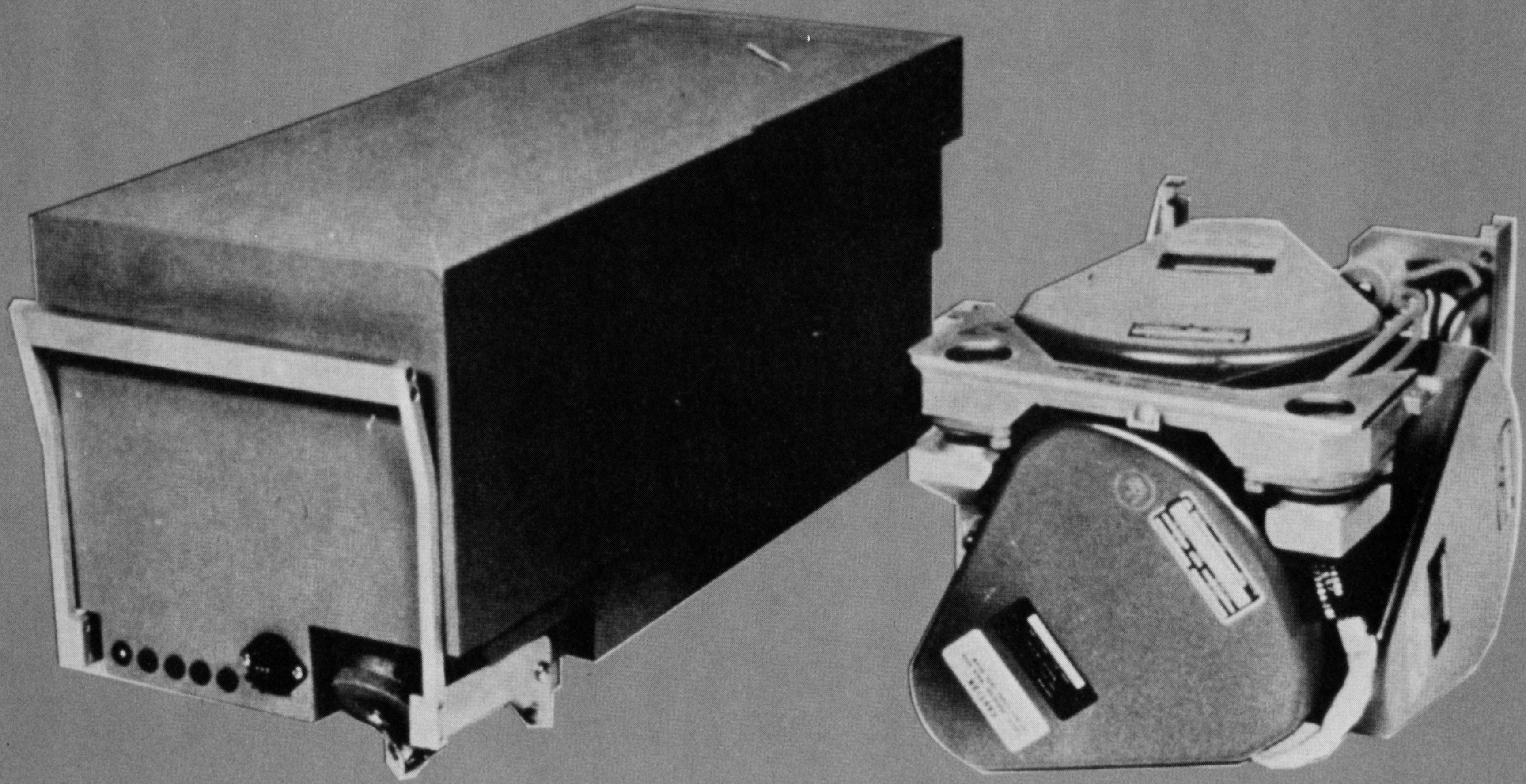
Air-to-Ground

- Improved Accuracy
  - CCIP 11-16 mils
  - CCRP 14-19 mils
- Current System
  - Manual 24-40 mils

Technology Enhancements

HUD/Weapons Delivery Computer
HUD/Weapons Delivery Computer/INS
Laser Ranger
Multimode Radar
Defensive Systems
Weapons
Air Refueling
Program Plan
Summary

Inertial Navigation Set (INS)

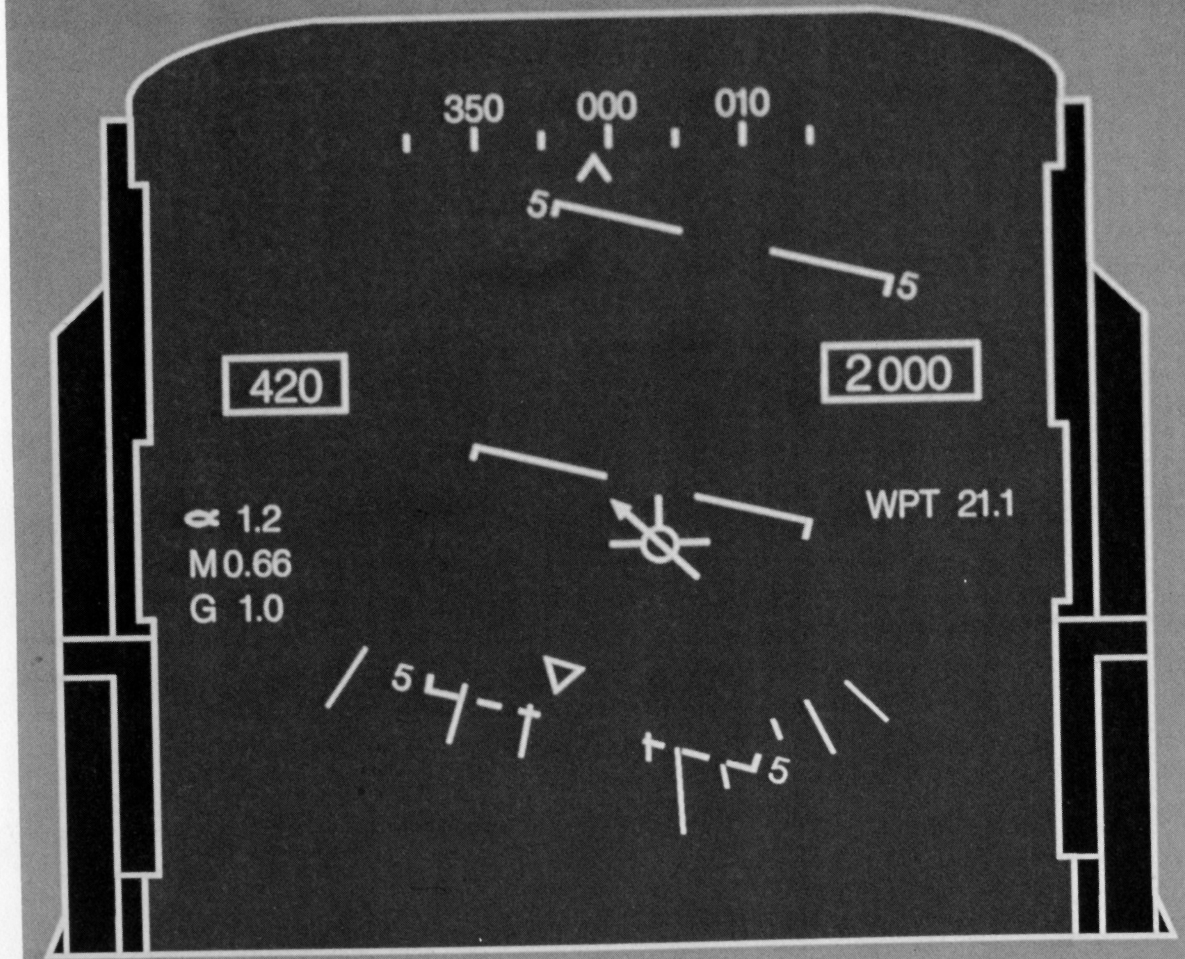


81-02113

86-0151
3G II

Head-Up Display

Navigation


350
000
010
5
5
420
2000
α 1.2
M0.66
G 1.0
WPT 21.1
5
5

- Heading
- Attitude
- Velocity Vector
- Altitude
- Airspeed, Mach
- Angle-of-Attack
- Bearing Indication
- Course Deviation
- Distance to Waypoint (NM)

Navigation Improvements

- Accurate Day/Night Navigation and Target Location
- Position Accuracy < 1.0 NM/hr
- Velocity Accuracy < 3 ft/sec
- Good Situation Awareness
- Flexible Waypoint Routing to Target
- Immune to External Interference and Jamming
- High-Speed Alignment in 22 sec (Full Alignment in 4 min)
- Reliability = 2000 hr MTBF

HUD/WDC/INS

Air-to-Air

- Further Advancement of Combat Capability

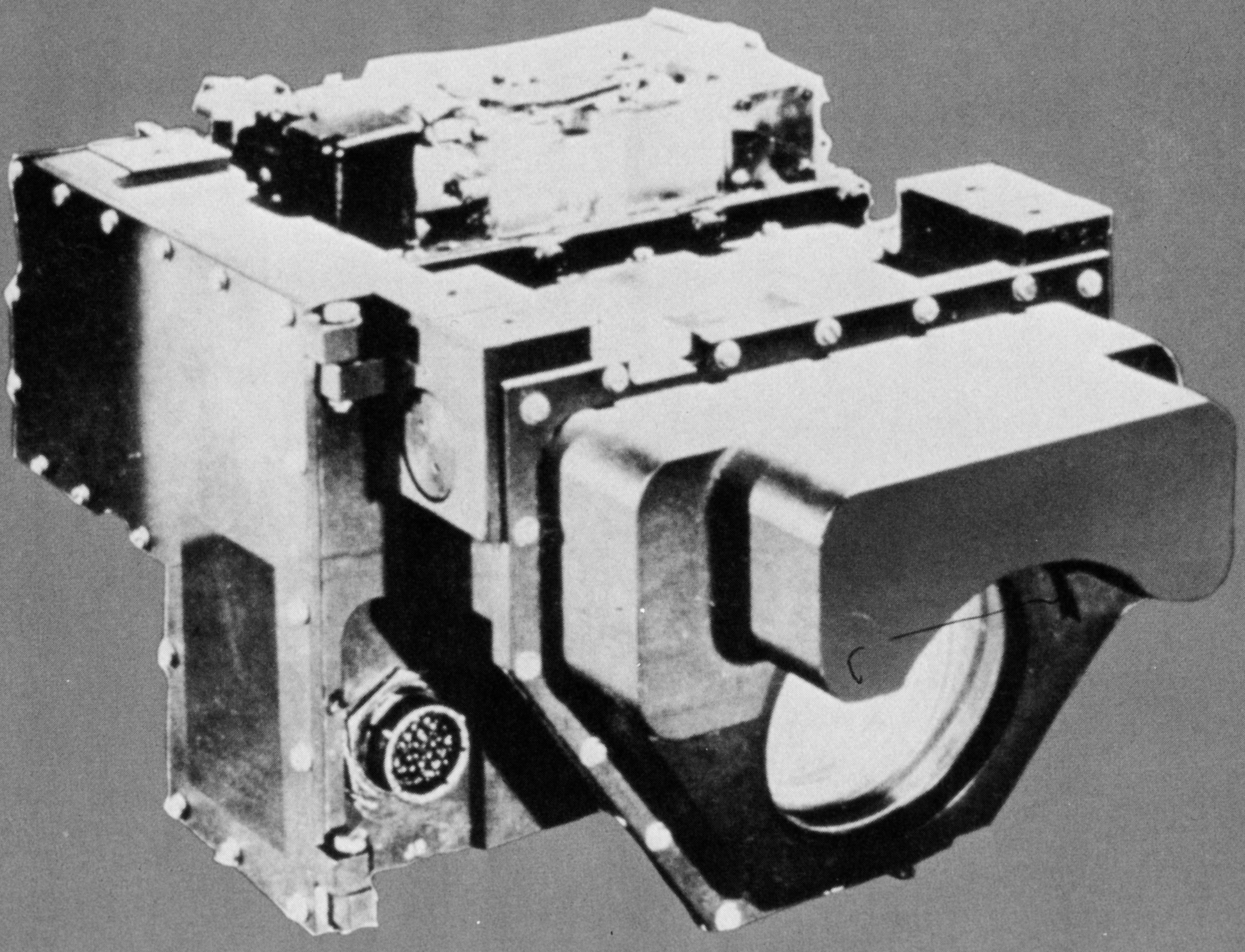
Air-to-Ground

- Improved Accuracy
  - CCIP 9-15 mils
  - CCRP 10-16 mils
- Current System
  - Manual 24-40 mils

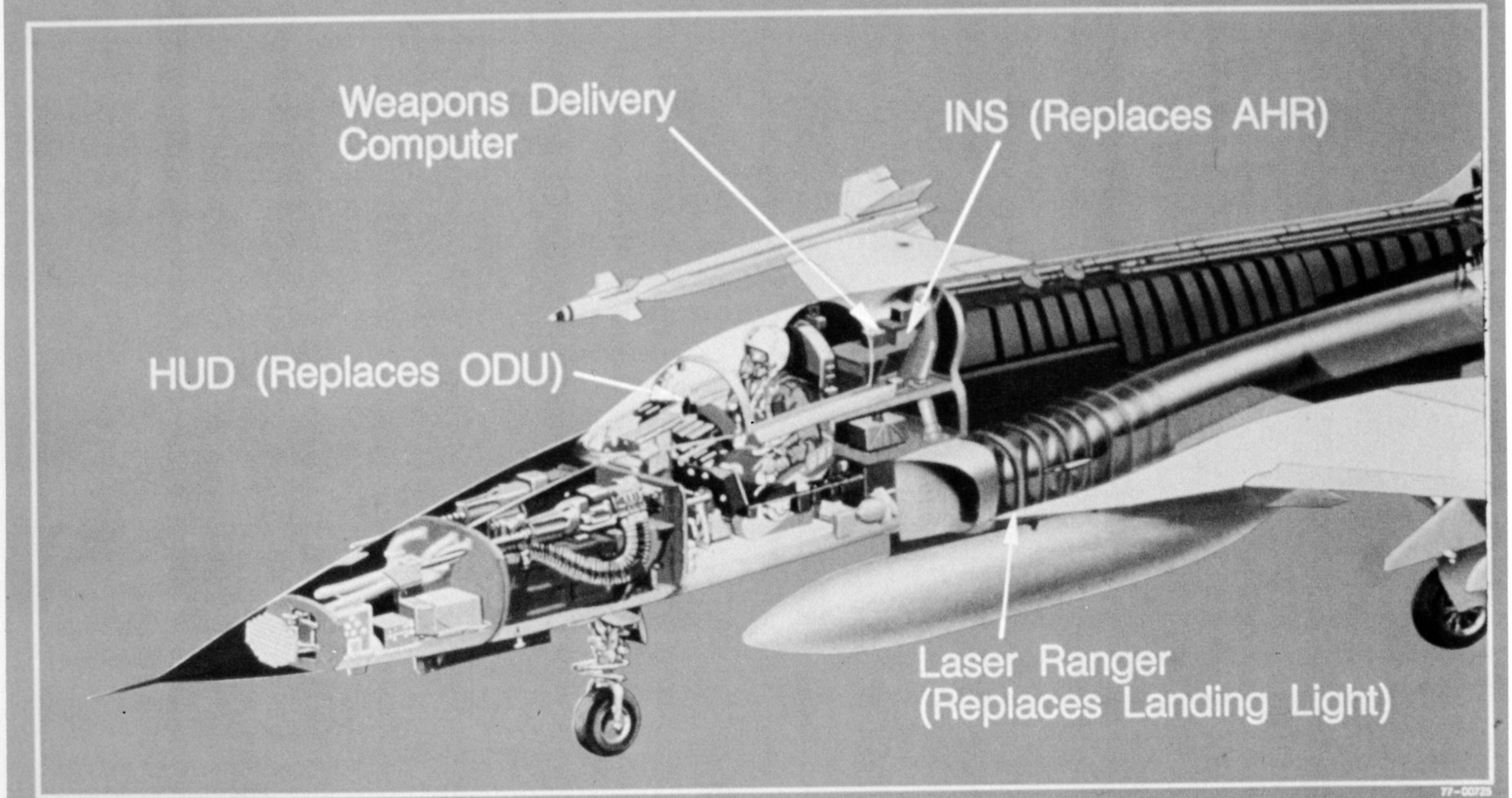
Technology Enhancements

- HUD/Weapons Delivery Computer
- HUD/Weapons Delivery Computer/INS
- **Laser Ranger**
- Multimode Radar
- Defensive Systems
- Weapons
- Air Refueling
- Program Plan
- Summary

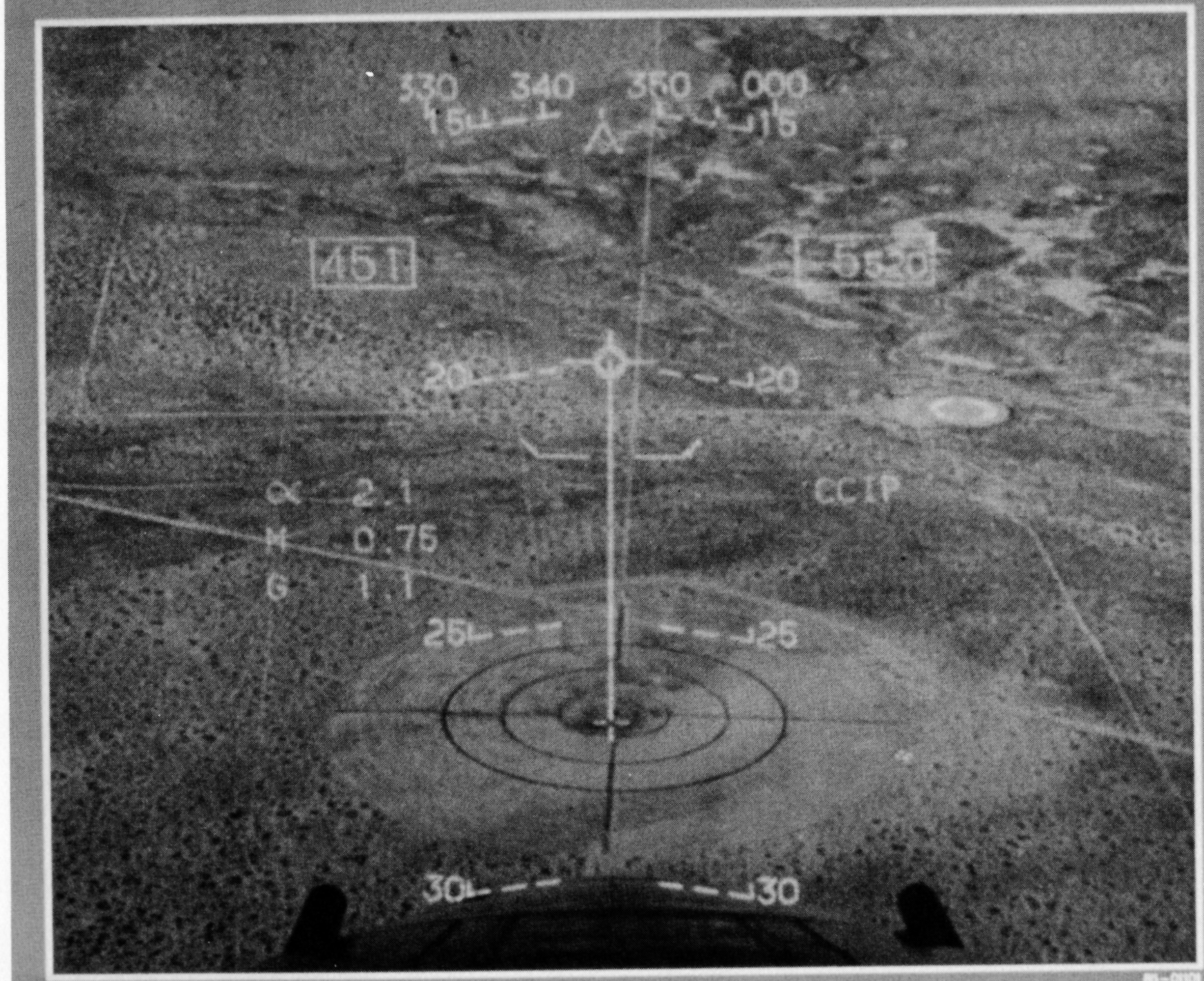
Laser Ranger



WDS Installation Concept


Weapons Delivery Computer
INS (Replaces AHR)
HUD (Replaces ODU)
Laser Ranger (Replaces Landing Light)
77-00725

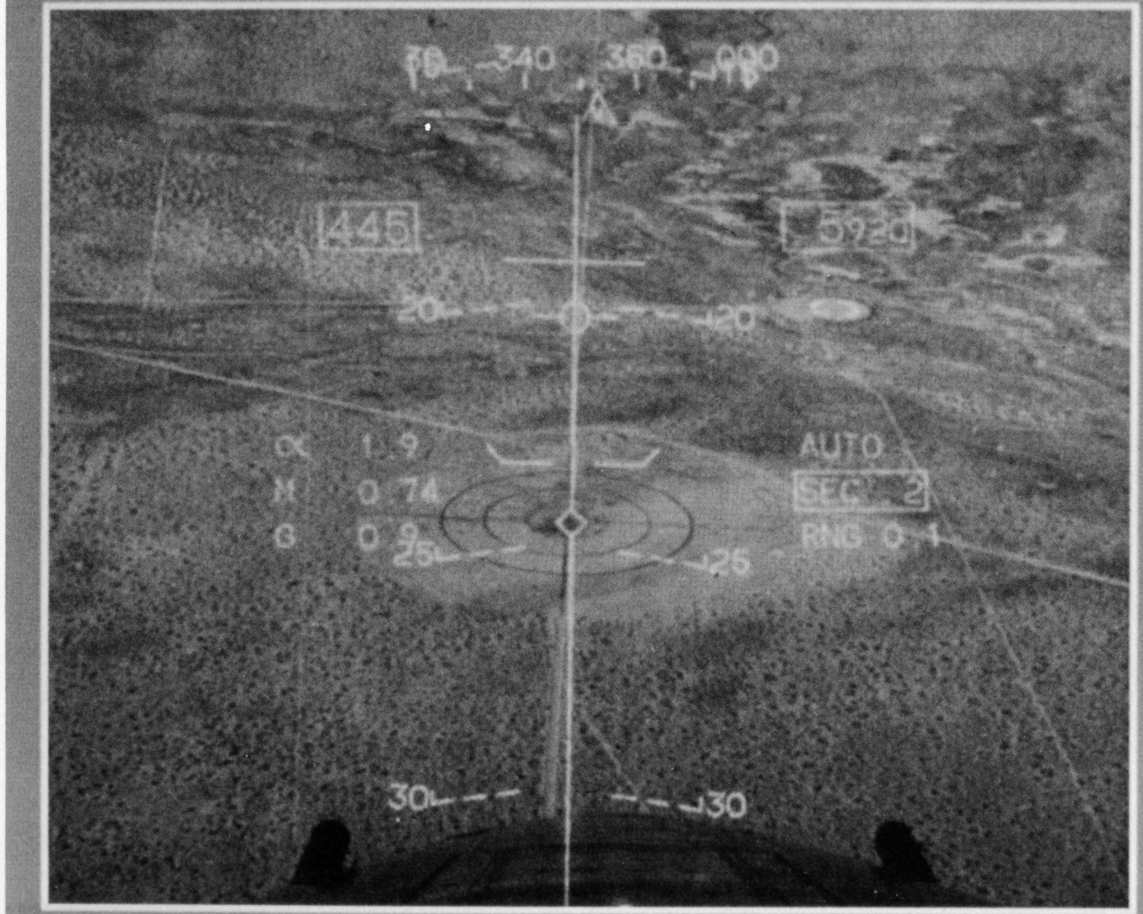
Continuously Computed Impact Point (CCIP)


330 340 350 000
15
15
451
5520
20
20
CCIP
α 2.1
M 0.75
G 1.1
25
25
30
30

86-0101

- Bomb Fall Line
- Impact Point
- Pull-Up Cue
- CEP 6-7 mils

Continuously Computed Release Point (CCRP) Auto

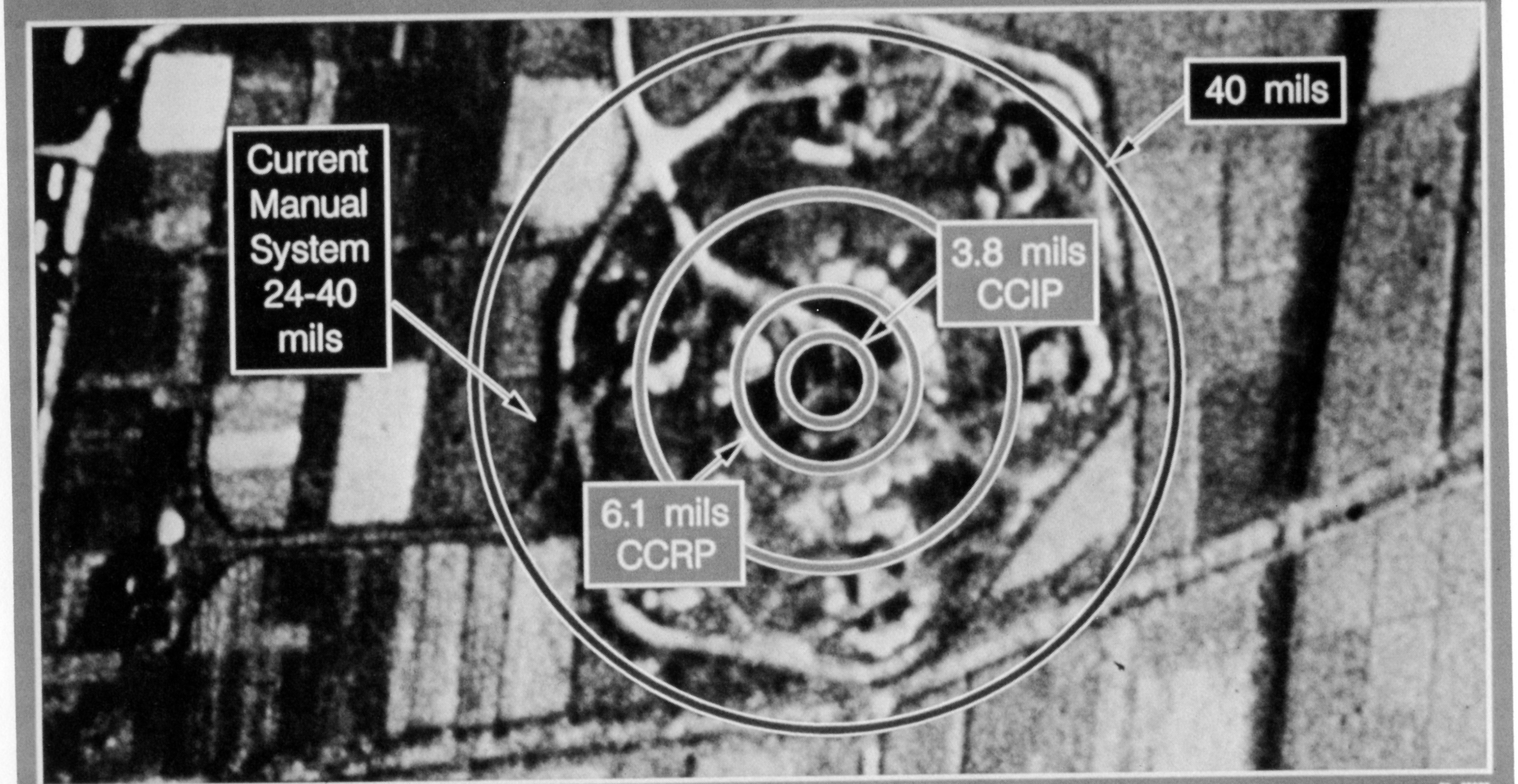

340
360
000
445
5920
20
20
α 1.9
M 0.74
G 0.9
AUTO
SEC 2
RNG 0.1
25
25
30
30

86-0144
3G II

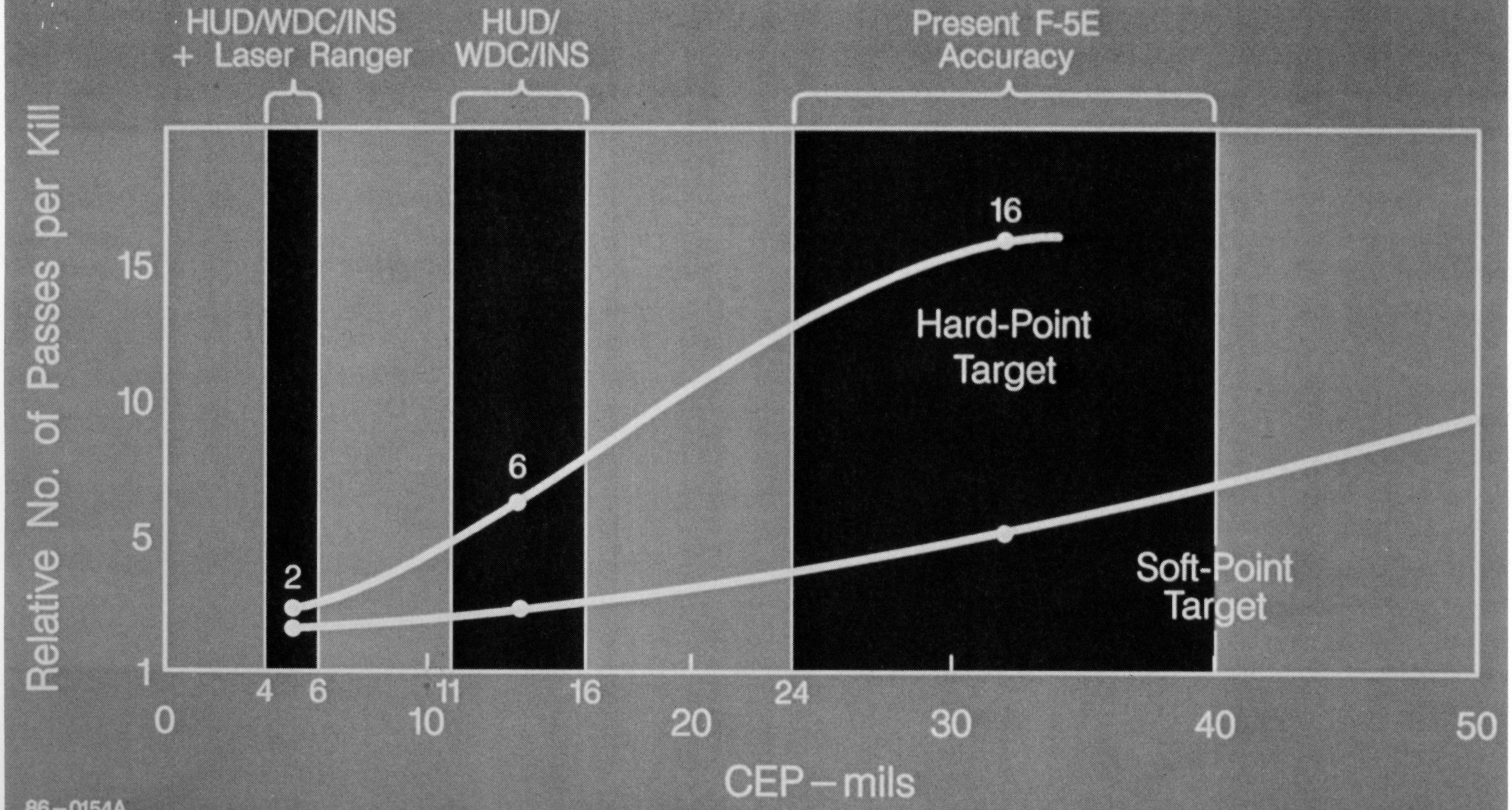
88-01100

- Azimuth Steering
- Target Location
- Target Range
- Time to Release
- Release Cue
- Pull-Up Cue
- CEP 8-9 mils

Demonstrated CCIP and CCRP Accuracy


40 mils
Current Manual System 24-40 mils
3.8 mils CCIP
6.1 mils CCRP

Bombing Effectiveness Vs CEP



86 – 0154A
4C I

Technology Enhancements

HUD/Weapons Delivery Computer

HUD/Weapons Delivery Computer/INS

Laser Ranger

Multimode Radar

Defensive Systems

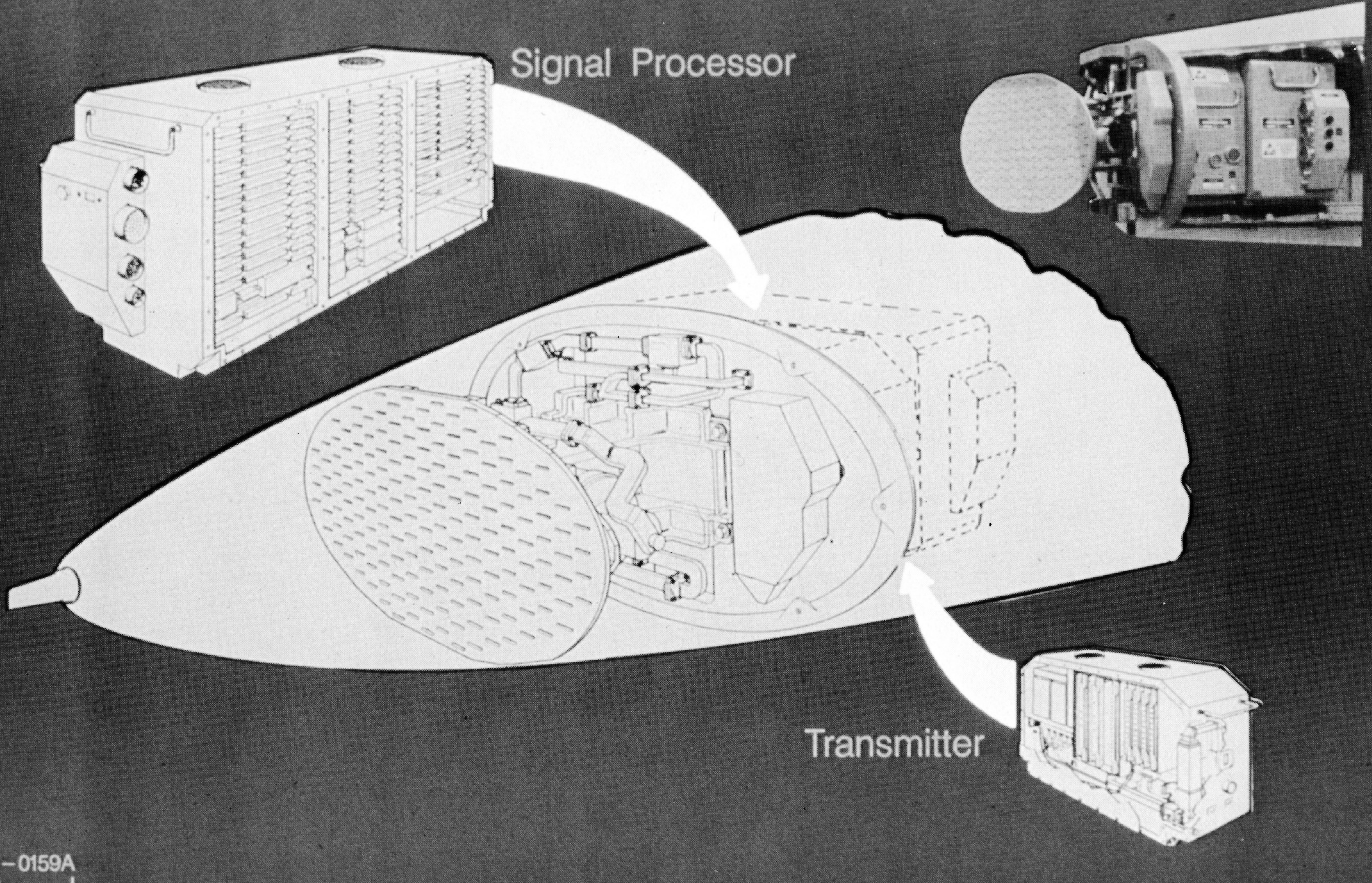
Weapons

Air Refueling

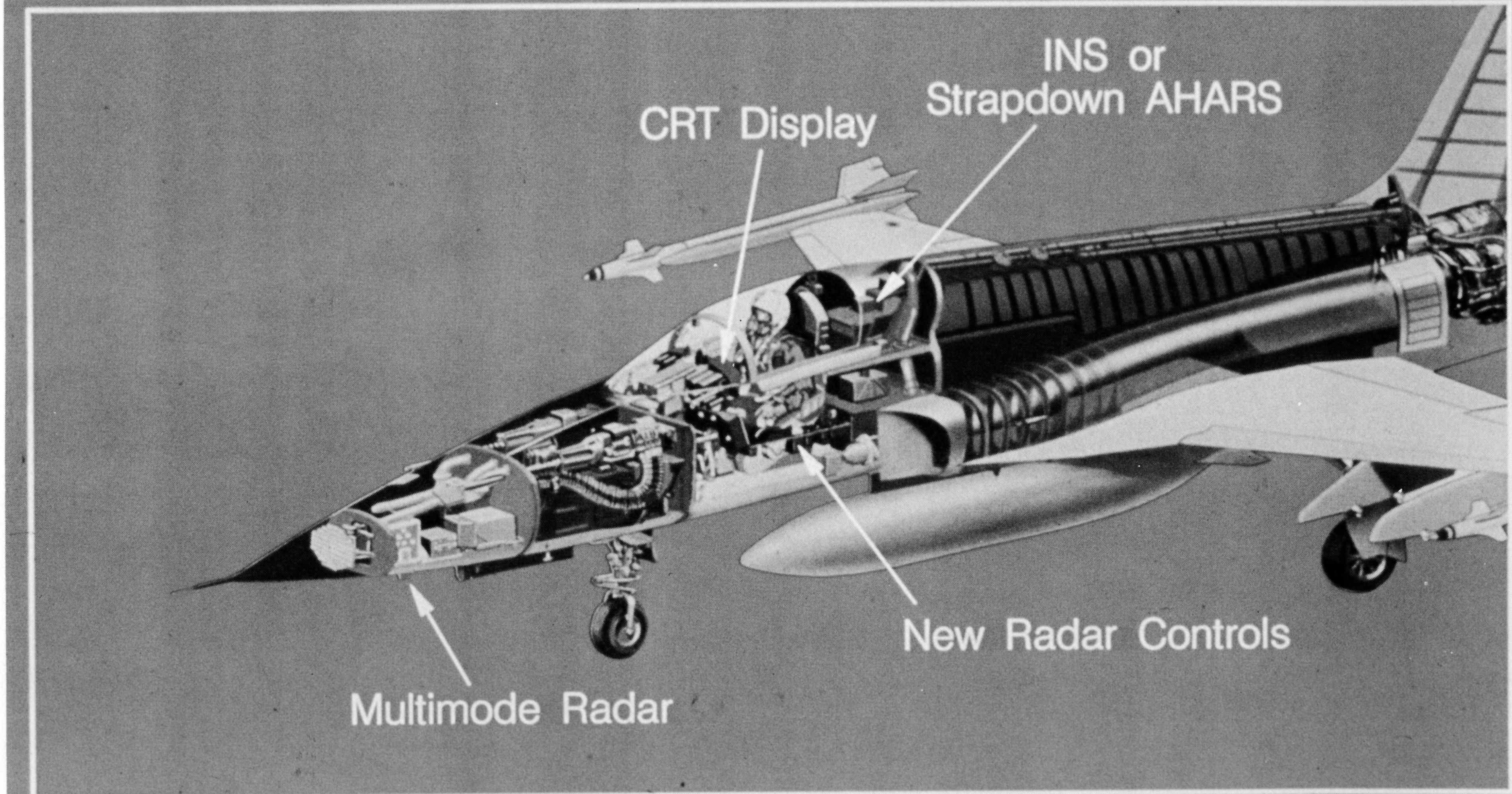
Program Plan

Summary

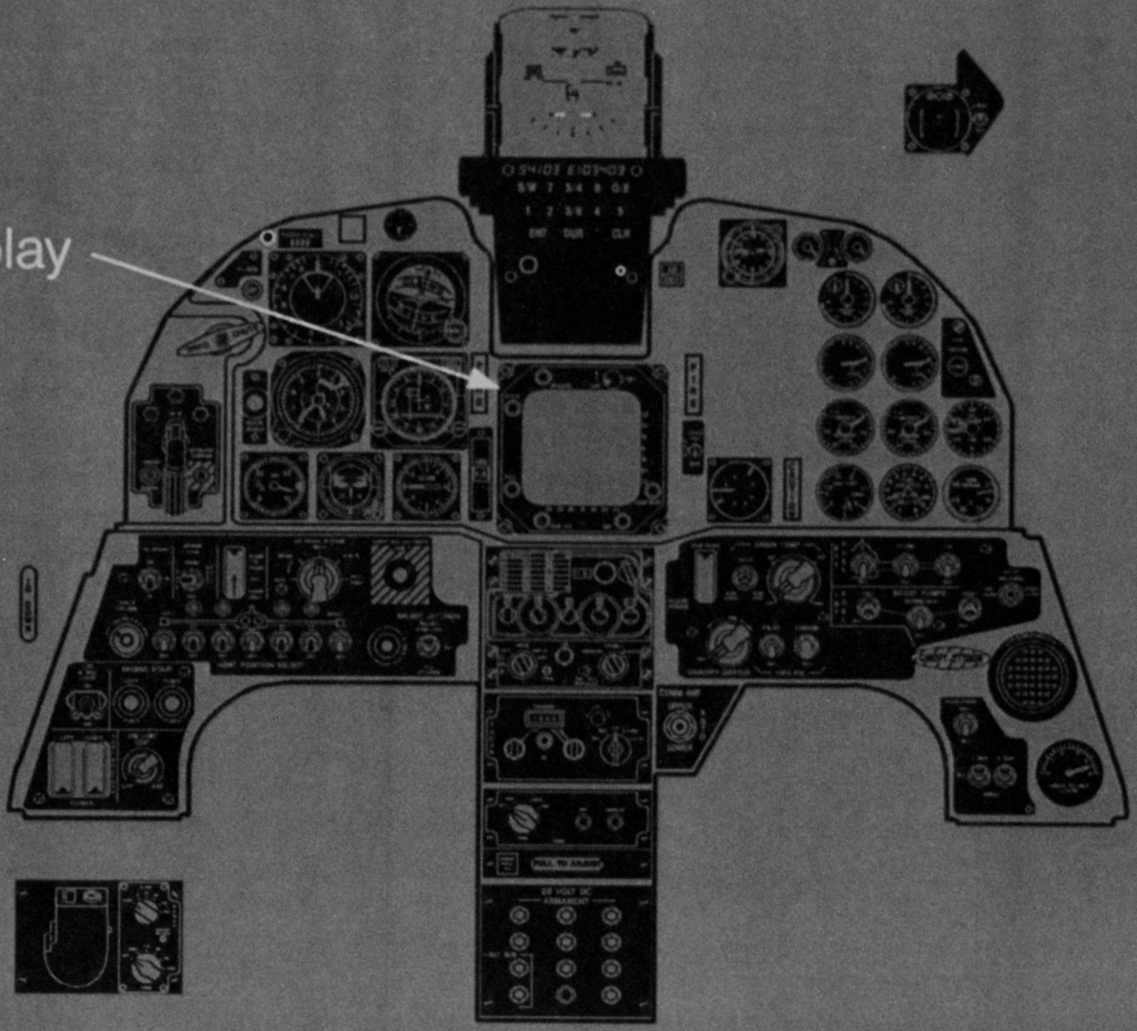
Multimode Radar for F-5E


Signal Processor
Transmitter

Radar Installation


INS or
Strapdown AHARS
CRT Display
New Radar Controls
Multimode Radar

Cockpit Arrangement



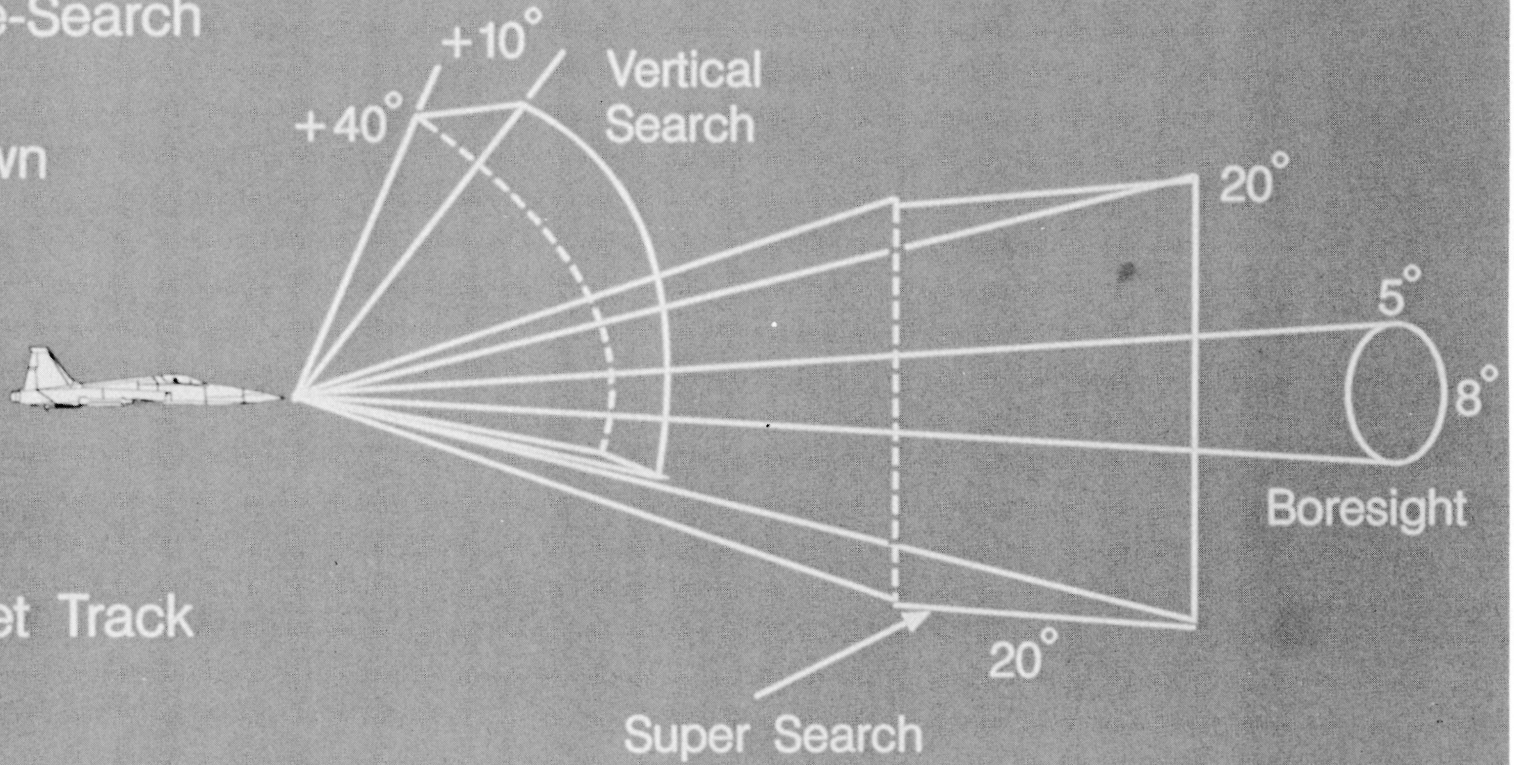
New CRT Display

Radar Control Panel

Air-to-Air Operational Modes

Air-to-Air Search

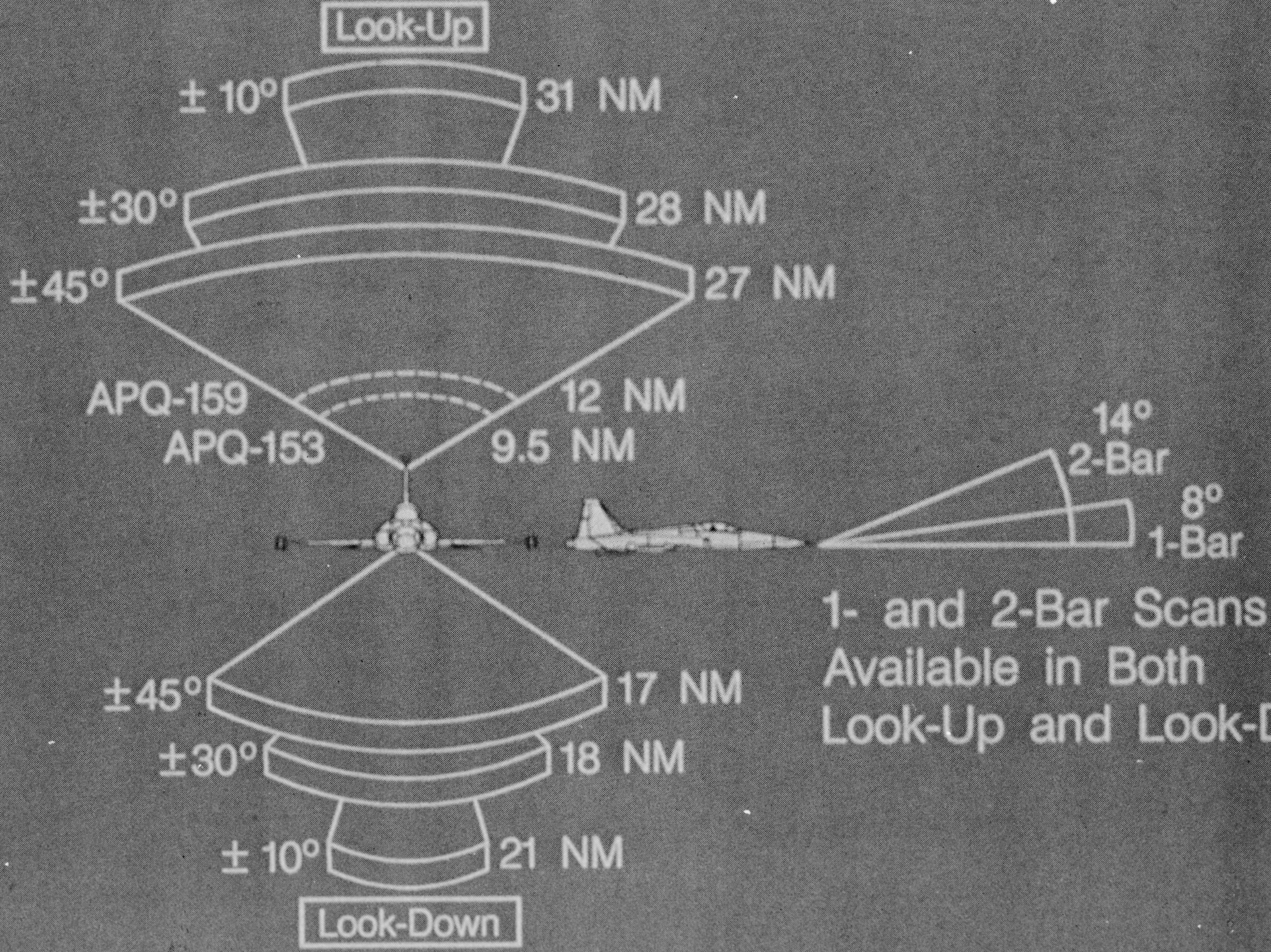
- Range-While-Search
  - Look-Up
  - Look-Down
- Air Combat


+10°
+40°
Vertical Search
20°
5°
8°
Boresight
20°
Super Search

Air-to-Air Track

- Single Target Track
- Air Combat

Air-to-Air Range Capability



Look-Up

2-Bar

±10° 31 NM

±30° 28 NM

±45° 27 NM

APQ-159 12 NM

APQ-153 9.5 NM

14° 2-Bar

8° 1-Bar

±45° 17 NM

±30° 18 NM

±10° 21 NM

2-Bar

Look-Down

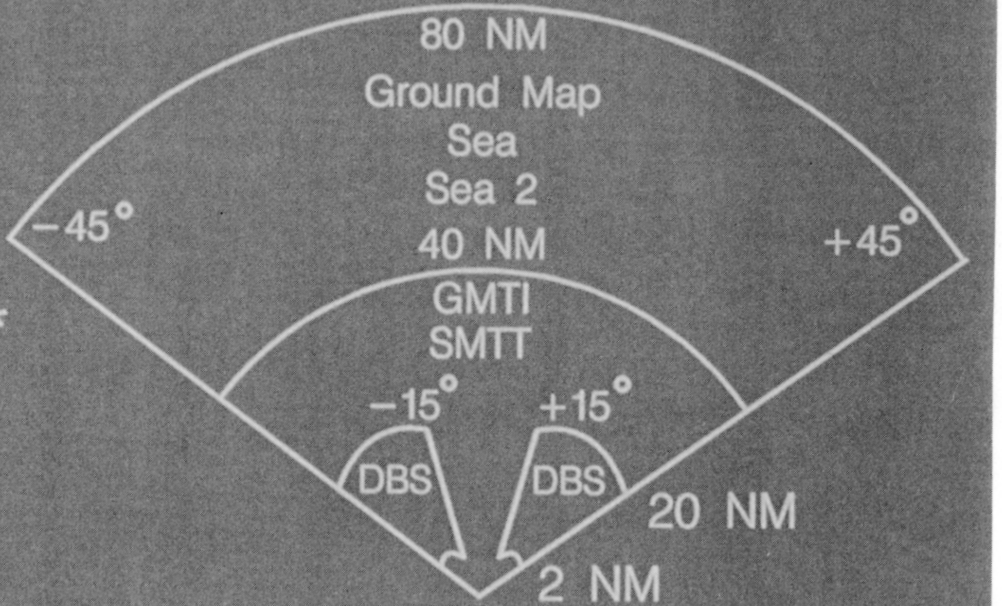
1- and 2-Bar Scans Available in Both Look-Up and Look-Down

86–0148A
3V I

Air-to-Surface Capability

Modes

- Real Beam Ground Map
  - Normal*
  - Expand*
- Doppler Beam Sharpening*
- Sea*
- Sea 2*
- Freeze
- Ground Moving Target Indication*
- Surface Moving Target Track
- Air-to-Ground Ranging


80 NM
Ground Map
Sea
Sea 2
-45°
+45°
40 NM
GMTI
SMTT
-15°
+15°
DBS
DBS
20 NM
2 NM

* Freeze Applies to These Modes

Multimode Radar

Air-to-Air

- Look-Up and Look-Down
- Detects Targets 60 sec Earlier
- First Shot Opportunity
- Radar-Directed Gun Firing (Snap-Shot)

Air-to-Ground

- High Resolution Ground Map
- Day/Night Moving Target Detection
- Air-to-Surface Range (All-Weather)

Plus

- Improved Reliability:
  MTBF > 150 hr (APQ-153 = 65 hr)
- Improved Maintainability

HUD/WDC/INS/Multimode Radar

Air-to-Air

- Improved Detection Range

	Look-Up	Look-Down
– Current	9.5	–
– Improved	31	21

Air-to-Ground

- Improved Accuracy
  - CCIP 4-5 mils
  - CCRP 5-6 mils
- Current System
  - Manual 24-40 mils

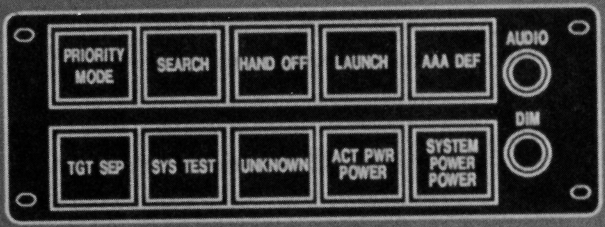
Technology Enhancements

HUD/Weapons Delivery Computer
HUD/Weapons Delivery Computer/INS
Laser Ranger
Multimode Radar
Defensive Systems
Weapons
Air Refueling
Program Plan
Summary

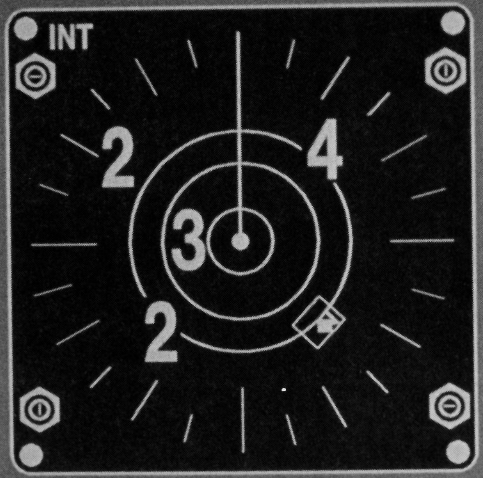
Combat Survivability

RWR

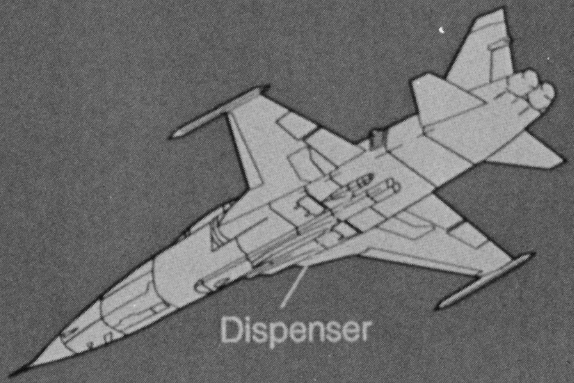
Indicator Control

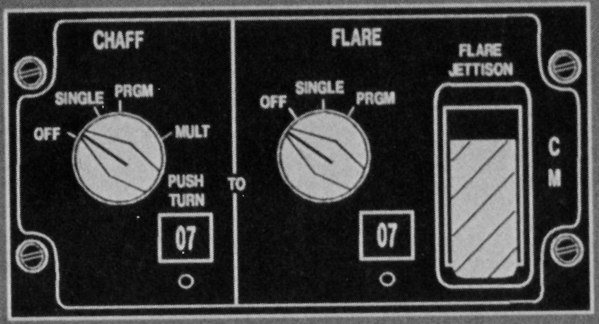

PRIORITY MODE
SEARCH
HAND OFF
LAUNCH
AAA DEF
AUDIO
DIM
TGT SEP
SYS TEST
UNKNOWN
ACT PWR POWER
SYSTEM POWER POWER

Azimuth Indicator



Chaff-Flare ALE-40




CHAFF
OFF
SINGLE
PRGM
MULT
PUSH TURN
07
TO
FLARE
OFF
SINGLE
PRGM
07
FLARE JETTISON
C
M

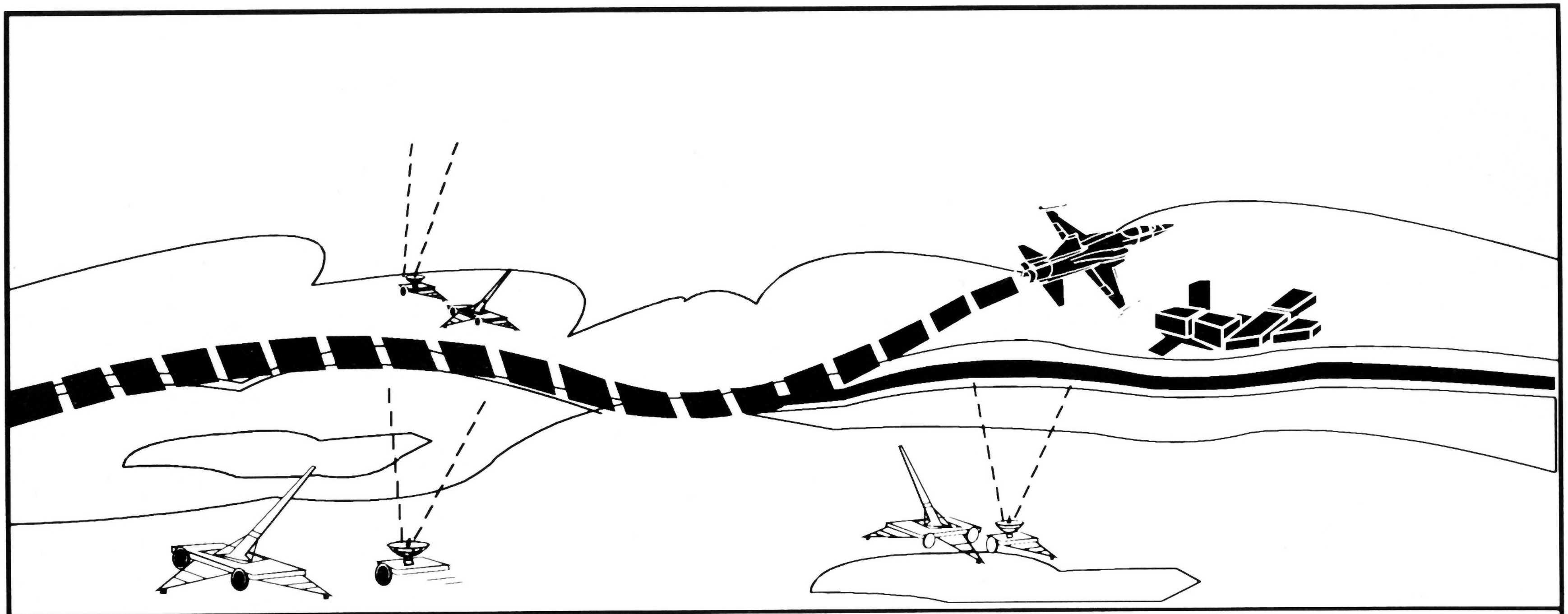
- Small Size
- Small Radar Cross Section
- Small Heat Signature

High Survivability

RWR Characteristics

- Frequency Coverage
  - E-J Bands
  - C and D Bands
- Angular Coverage
  - 360°, ± 60° Elevation
- Signal Processor
  - High Multithreat Capability
  - High Reliability
- Relative-Bearing and Threat Identification Display
  - 3-in. CRT
- Sensitivity
  - 1.5-2 Times Threat Lethal Radius
- SAM-Launch Correlation
  - Yes
- Threat Priority
  - Yes
- Display Clutter
  - AAA-Threat Removal
  - Priority-Mode Gain Control

RADAR WARNING RECEIVER

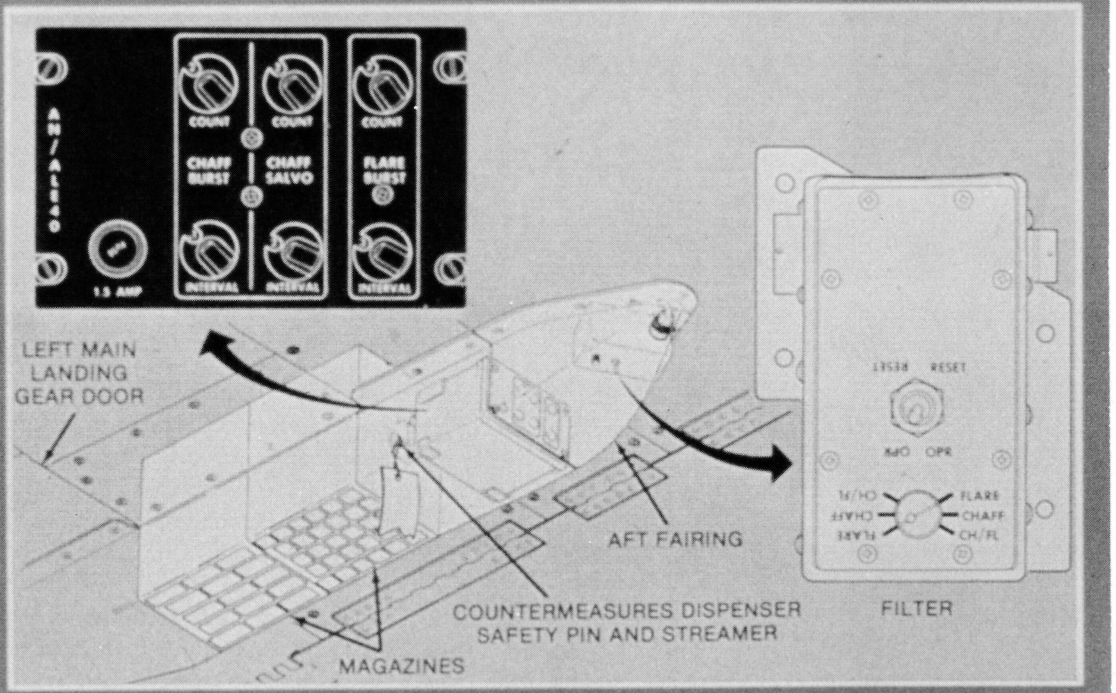


ALLOWS AVOIDANCE OF ENEMY DEFENSIVE INSTALLATIONS

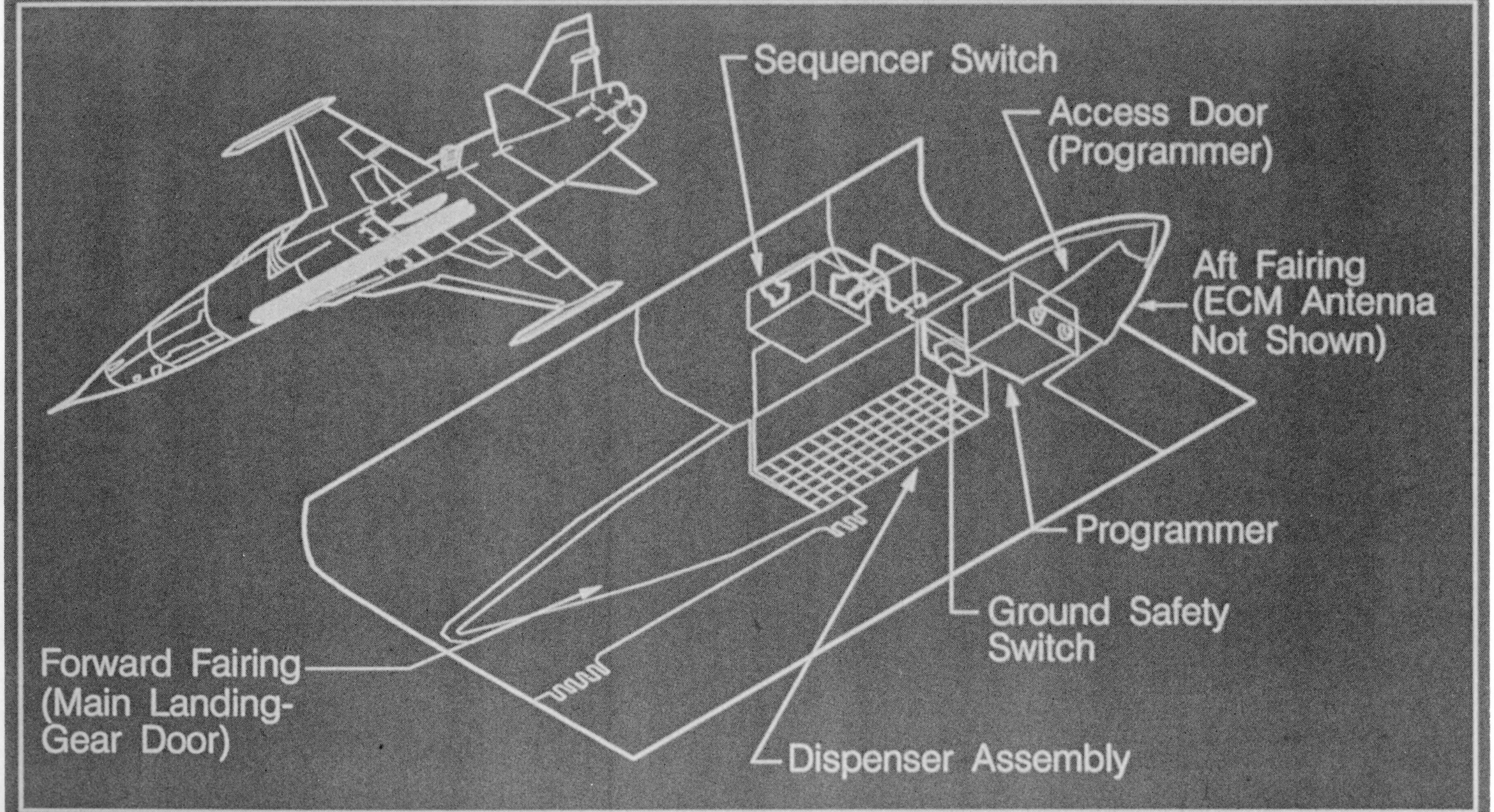
- Passively detects, locates, classifies and determines priorities of threat radars
- Allows optimum evasive maneuvers

Chaff-Flare Dispenser

- Single Release
- Programmed Pattern
- Load Options
  - 60 Chaff
  - 30 Flare
  - 30 Chaff +
    15 Flare

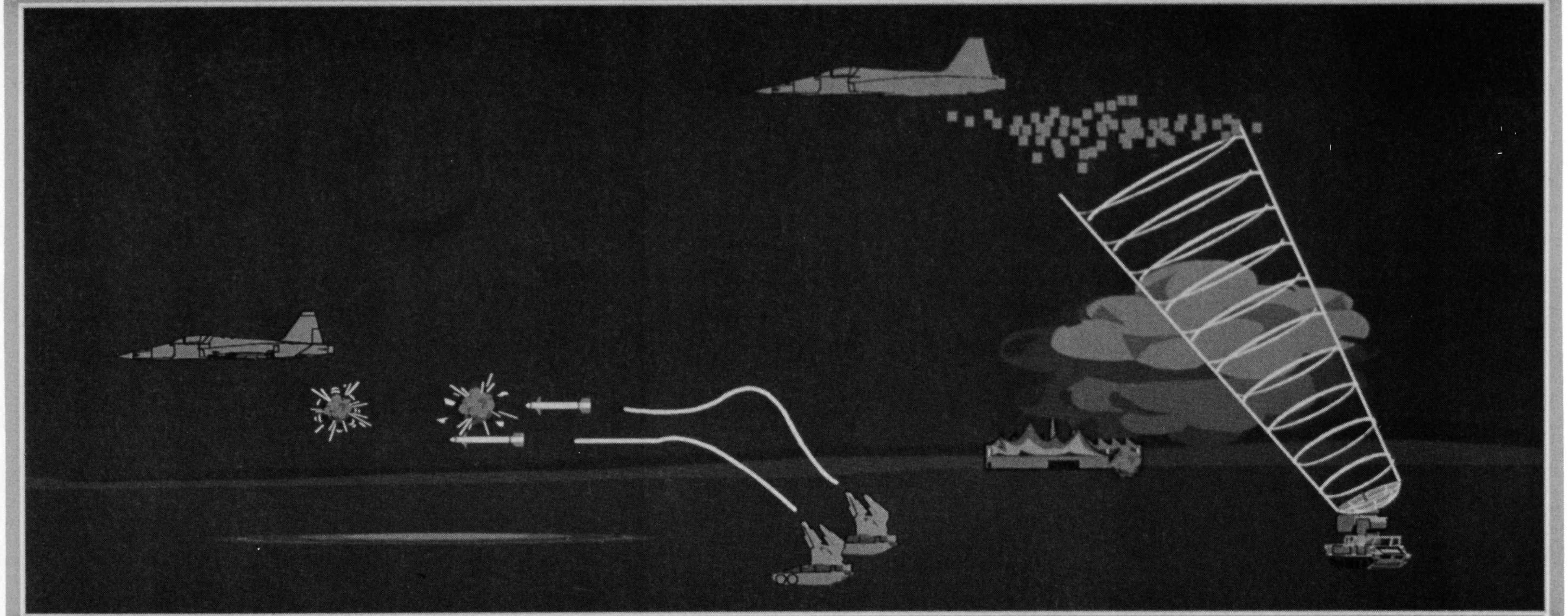

AN/ALE40
COUNT
CHAFF BURST
INTERVAL
COUNT
CHAFF SALVO
INTERVAL
COUNT
FLARE BURST
INTERVAL
1.5 AMP
LEFT MAIN LANDING GEAR DOOR
AFT FAIRING
COUNTERMEASURES DISPENSER SAFETY PIN AND STREAMER
MAGAZINES
RESET
OPR
FLARE
CHAFF
CH/FL
FILTER

Chaff-Flare Dispenser Installation


Sequencer Switch
Access Door (Programmer)
Aft Fairing (ECM Antenna Not Shown)
Programmer
Ground Safety Switch
Forward Fairing (Main Landing-Gear Door)
Dispenser Assembly

Chaff-Flare Dispenser

AN/ALE-40



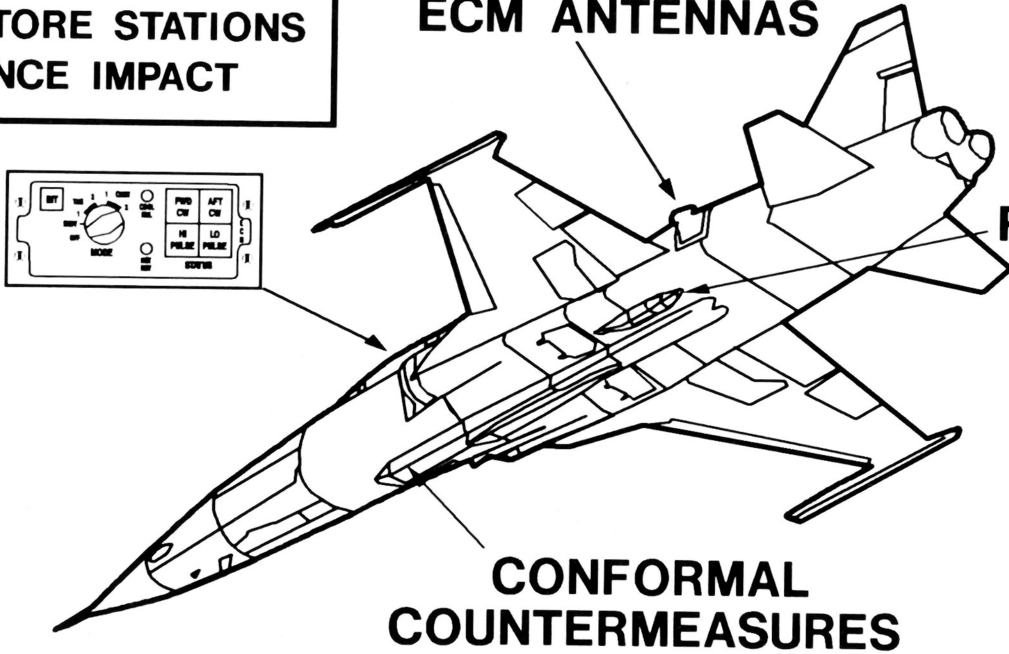
Counters Radar-Directed and Infrared-Guided Threats

- Chaff Breaks Threat Radar Tracking
- Flares Decoy Infrared-Guided Missiles

CONFORMAL COUNTERMEASURES SYSTEM

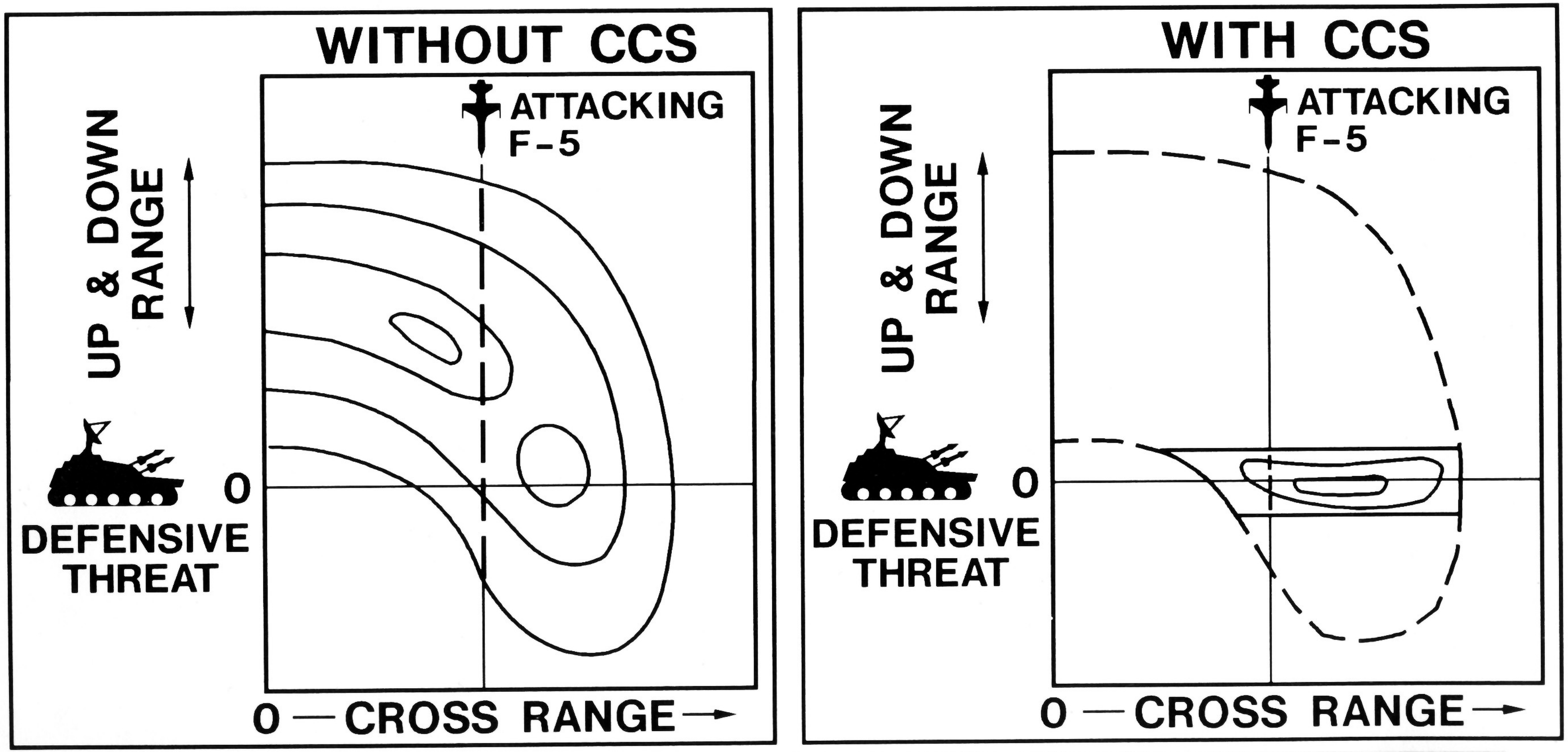
Configuration

- CONFORMALLY MOUNTED
- PRESERVES ALL STORE STATIONS
- SMALL PERFORMANCE IMPACT


AFT UPPER ECM ANTENNAS
COCKPIT CONTROLS
BIT
MODE
OFF
FWD CW
AFT CW
HI PULSE
LO PULSE
STATUS
AFT ECM RECEIVING ANTENNA
CONFORMAL COUNTERMEASURES SYSTEM

VULNERABILITY REDUCTION

Typical F-5 Threat Encounter


WITHOUT CCS
ATTACKING F-5
UP & DOWN RANGE
0
DEFENSIVE THREAT
0 — CROSS RANGE →
WITH CCS
ATTACKING F-5
UP & DOWN RANGE
0
DEFENSIVE THREAT
0 — CROSS RANGE →

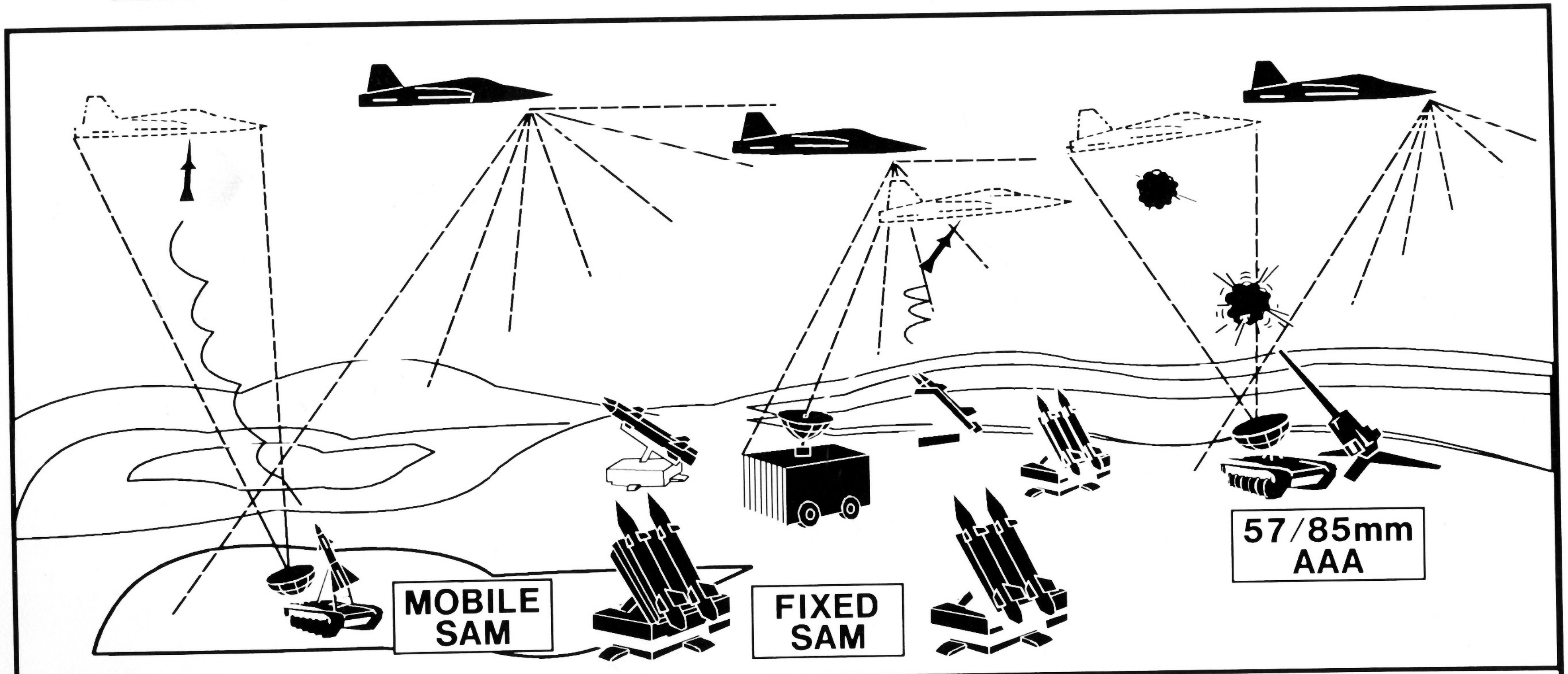
VULNERABILITY REDUCTION WITH CCS: ABOUT 90%

85-0023
3U I

CCS FUNCTIONS

- JAMS RADARS IN E-J BANDS
- MONITORS ELECTRONIC-SIGNAL ENVIRONMENT
- DETECTS AND IDENTIFIES THREAT SIGNALS
- SELECTS APPROPRIATE COUNTERMEASURES
- TRANSMITS JAMMING SIGNALS
- HANDLES MULTIPLE THREATS
- MONITORS FOR FAULTS CONTINUOUSLY
- TESTS COMPLETE SYSTEM (USING BUILT-IN EQUIPMENT) AT PILOT'S DIRECTION

ELECTRONIC COUNTERMEASURES


MOBILE SAM
FIXED SAM
57/85mm AAA

DEGRADES THREAT RADAR TRACKING CAPABILITY

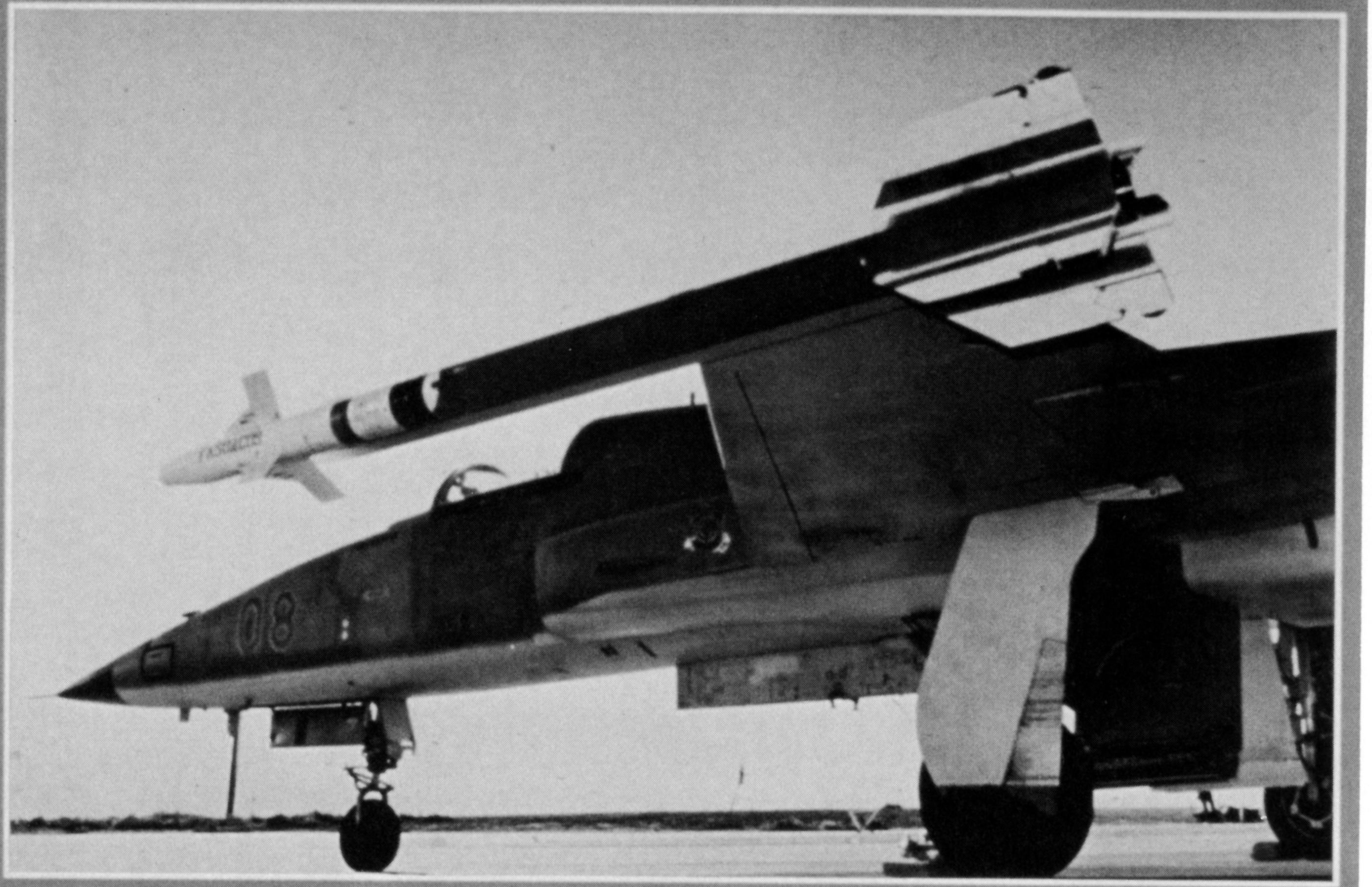
- Creates false targets
- Hides aircraft in noise

Technology Enhancements

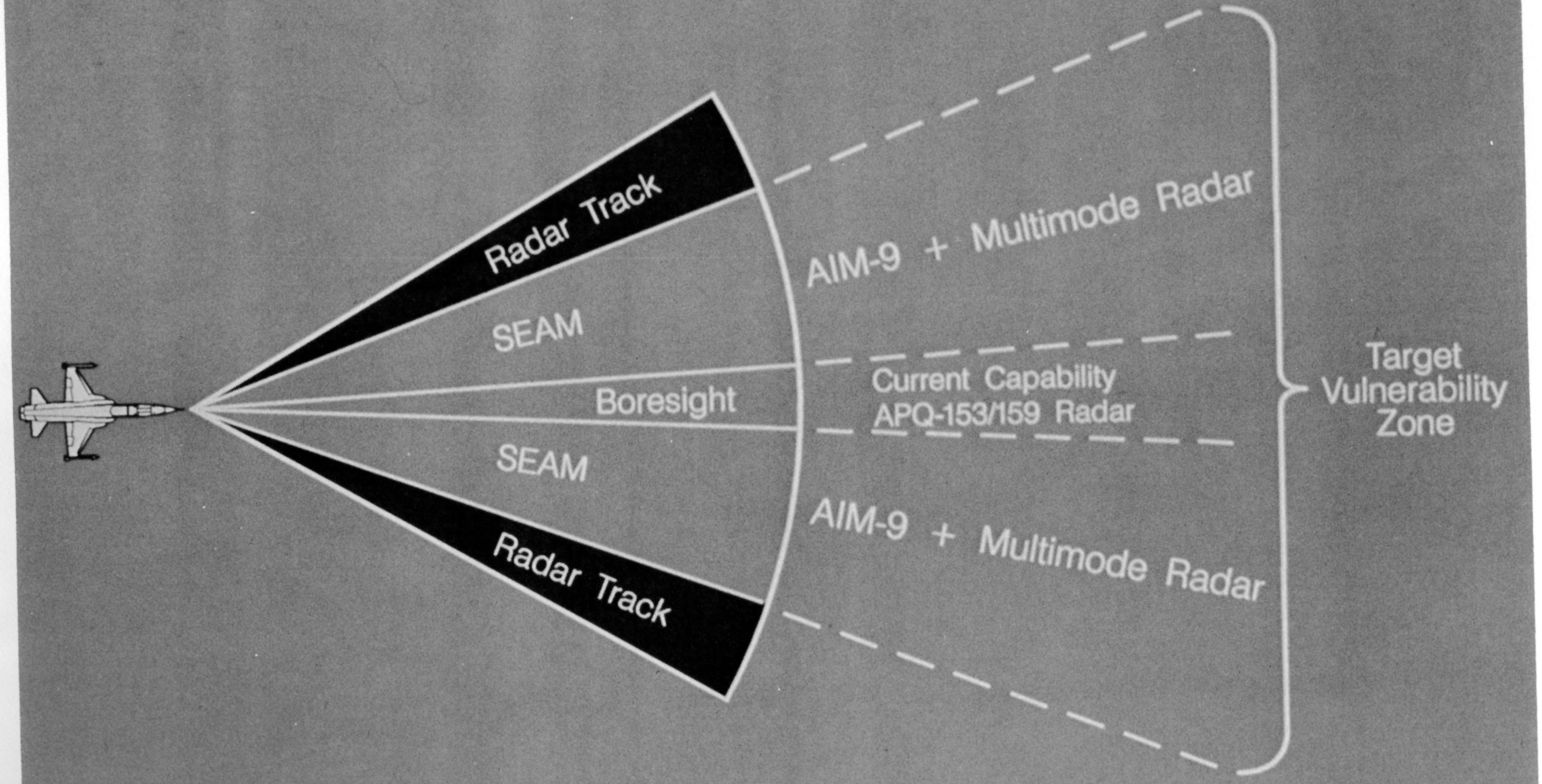
- HUD/Weapons Delivery Computer
- HUD/Weapons Delivery Computer/INS
- Laser Ranger
- Multimode Radar
- Defensive Systems
- Weapons
- Air Refueling
- Program Plan
- Summary

AIM-9P4 IR Missile

- All-Aspect Attack
- Improved Background Discrimination
- Expanded Firing Envelope
- Off-Boresight Acquisition (SEAM)



F-5/AIM-9P4 Target Acquisition Envelope



Radar Track

SEAM

Boresight

SEAM

Radar Track

AIM-9 + Multimode Radar

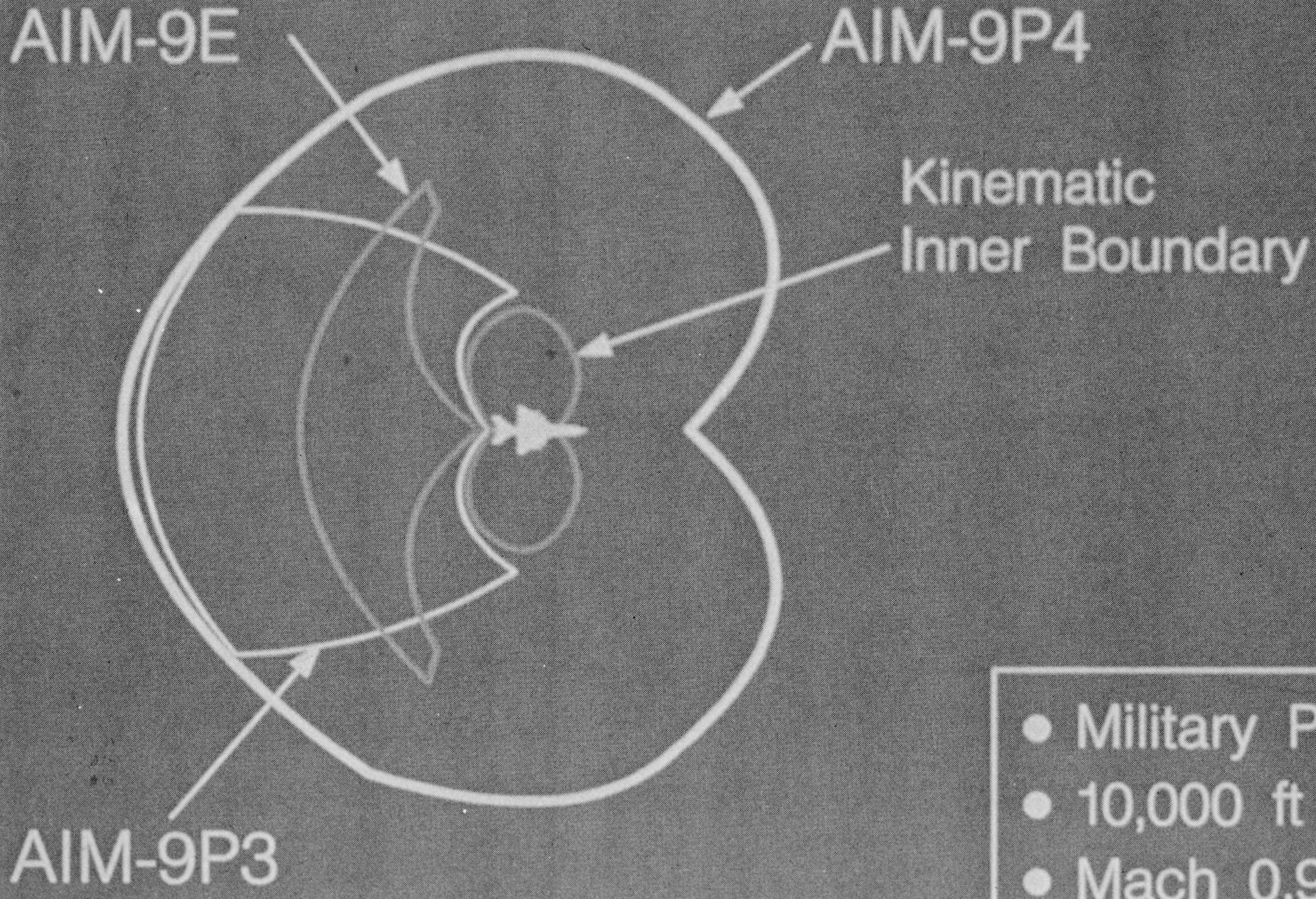
Current Capability
APQ-153/159 Radar

AIM-9 + Multimode Radar

Target
Vulnerability
Zone

85–0064B
3G,3R I

AIM-9 Missile Launch Envelopes


AIM-9E
AIM-9P4
Kinematic
Inner Boundary
AIM-9P3

- ● Military Power
- ● 10,000 ft
- ● Mach 0.9

86–0161A
3H III

Avionics Update

Provides Multimode Radar/HUD/WDC/INS

- All-Aspect Target Detection and Track
- All-Aspect Missile Launch Computations
- Look-Down (Radar)/Shoot-Down (AIM-9P4)
- Sidewinder Expanded Acquisition Mode (SEAM)

F-5E Present Capability

- Boresight Attack (No SEAM)
  - APQ-153 Has No Angle Track
- Rear Hemisphere Missile Envelope Computations

AIM-9P4 Benefits

Avionics Enhancements Give Full AIM-9P4 Implementation:

- Forward Aspect Attack
- Expanded Aft Hemisphere Launch Envelope
- Off-Boresight Acquisition and Launch
- Improved First-Shoot Opportunity
- Modified Existing Missiles or New Missiles
- Minimal Logistics Impact

Provides All-Aspect Missile Attack Capability at an Affordable Cost

86–0176
3H I

AGM-65A MAVERICK MISSILE

TARGETS

- ALL TANKS
- VEHICLES
- FORTIFICATIONS
- INSTALLATIONS

V-2 77-0129B
3G II

77-02343

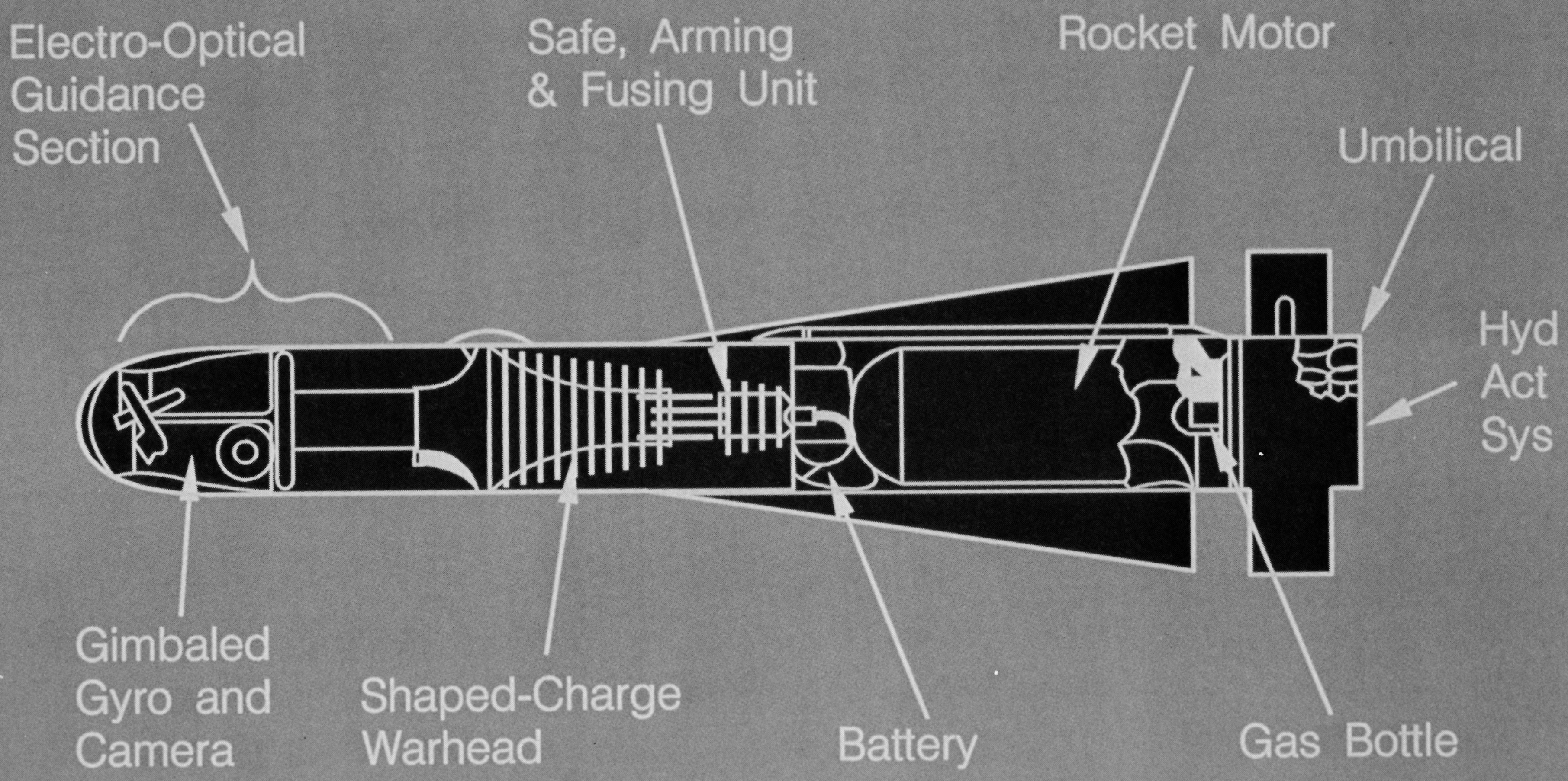
F-5E/F Qualified for 4 Mavericks

77-02344

Characteristics

- Electro-Optical Guidance
- Standoff
- Launch and Leave
- Weight: 500 lb
- Warhead: 125 lb Shaped Charge

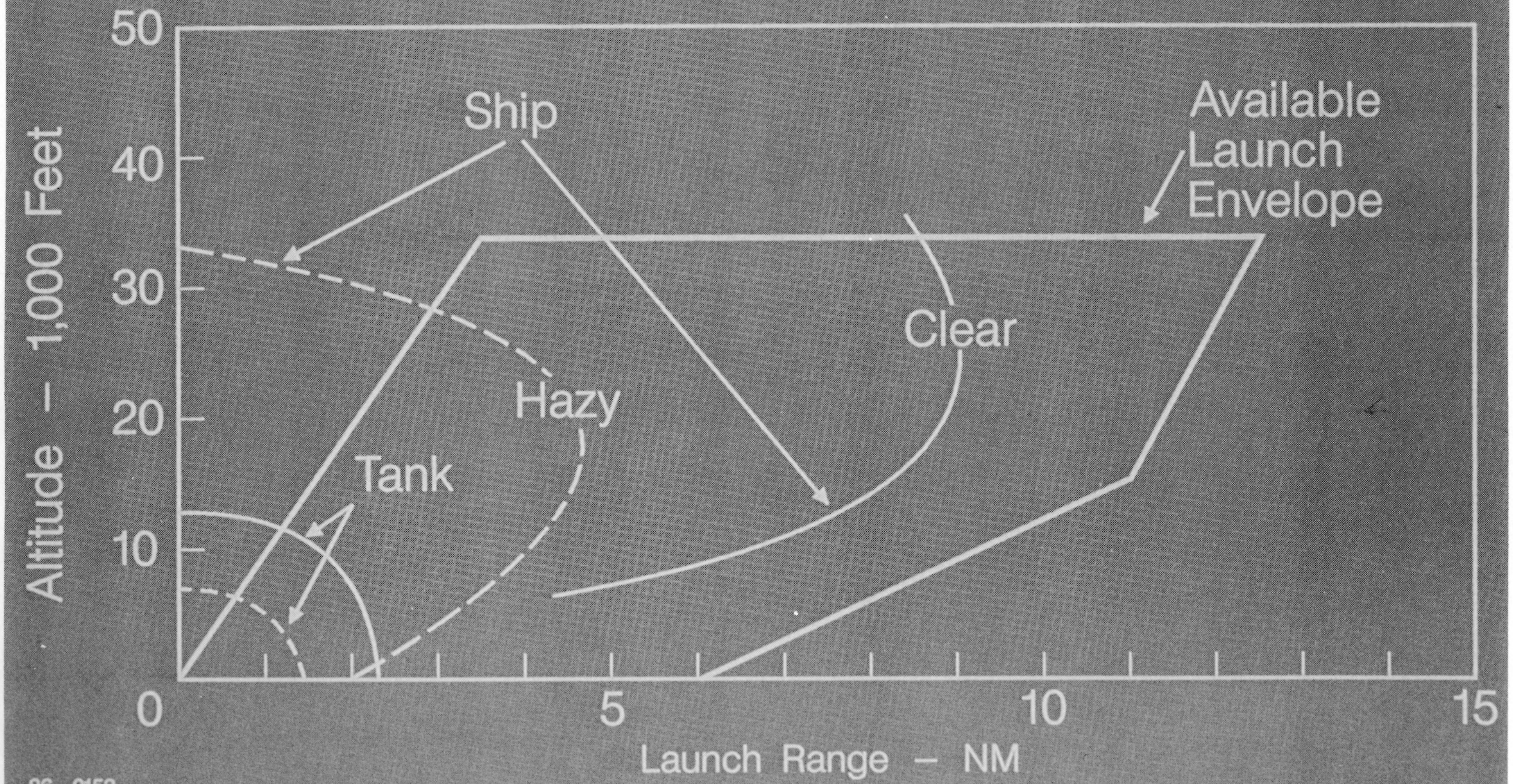
Maverick Components


Electro-Optical Guidance Section
Safe, Arming & Fusing Unit
Rocket Motor
Umbilical
Hyd Act Sys
Gimbaled Gyro and Camera
Shaped-Charge Warhead
Battery
Gas Bottle

85–0035A
3H, 4C I

Maverick Launch Envelope

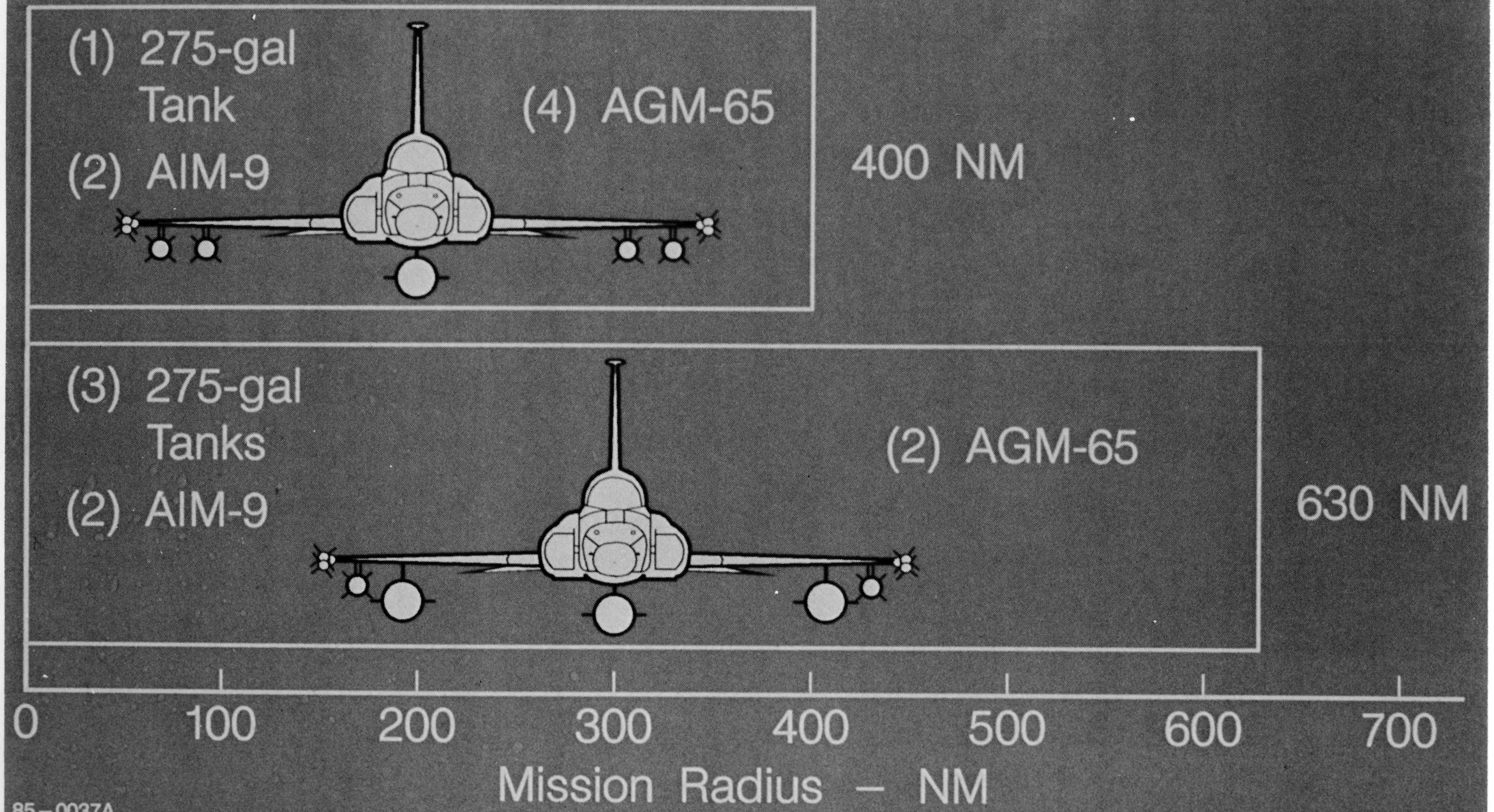
Visual Recognition



86 – 0153
3H II

Configuration Vs Performance

Hi-Lo-Hi



(1) 275-gal Tank

(2) AIM-9

(4) AGM-65

400 NM

(3) 275-gal Tanks

(2) AIM-9

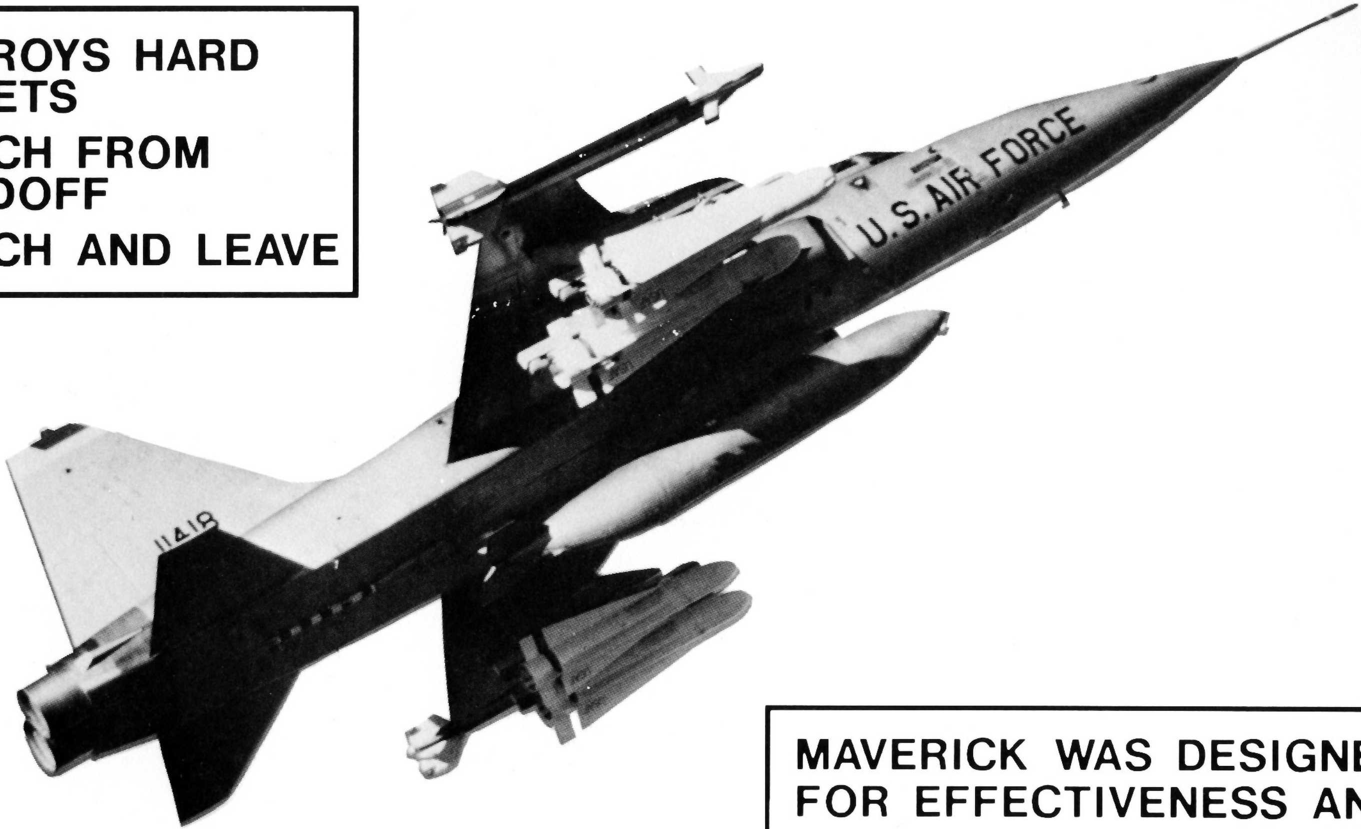
(2) AGM-65

630 NM

85–0037A
3H, 4B, 4C I

MAVERICK OPERATIONAL BENEFITS

- DESTROYS HARD TARGETS
- LAUNCH FROM STANDOFF
- LAUNCH AND LEAVE



MAVERICK WAS DESIGNED FOR EFFECTIVENESS AND SURVIVABILITY

GPU-5/A 30mm Gun Pod

79-01346

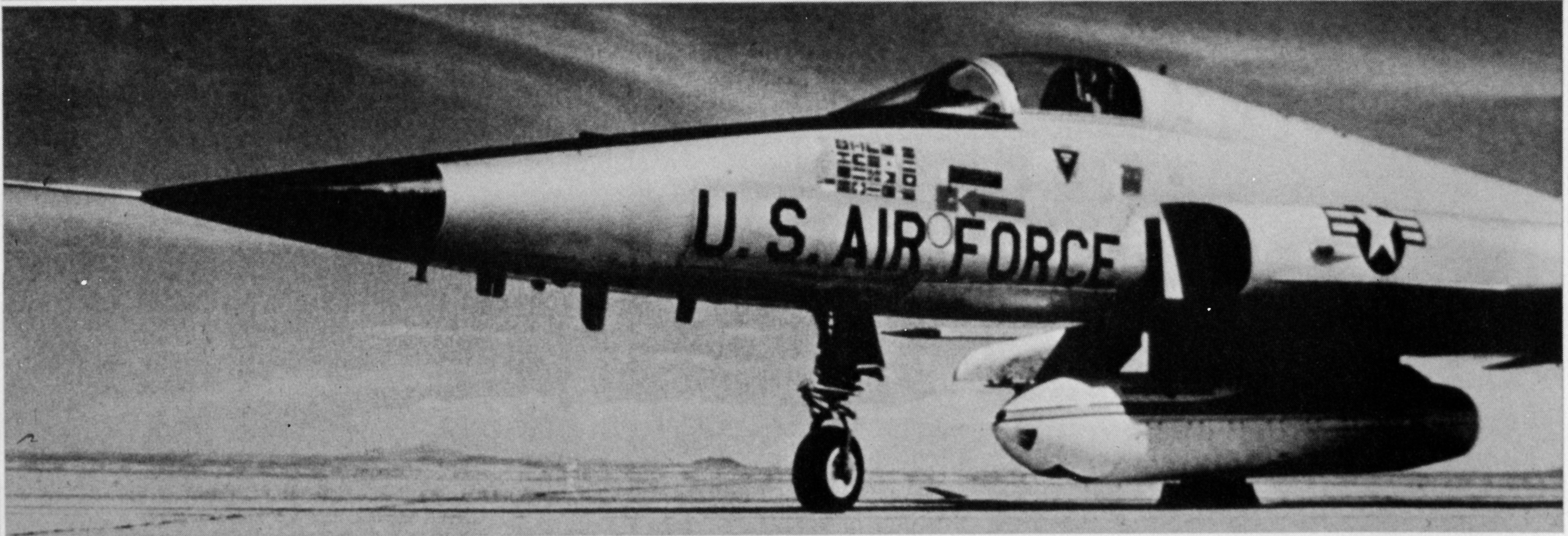
Hard Point Targets

- Tanks
- Armored Vehicles
- Bunkers
- Ships

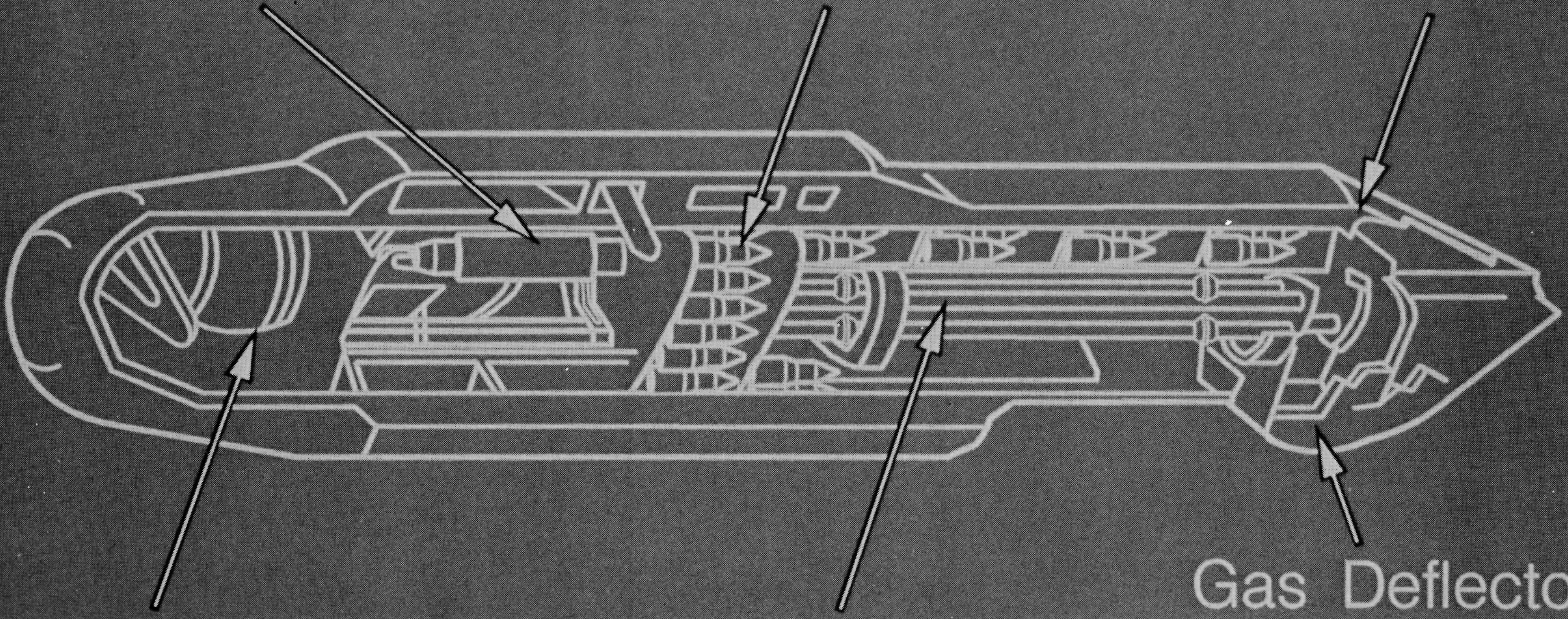
F-5E Qualified for 30mm Gun Pod

Gun Pod Characteristics

Description:	4-Barrel, Gatling Type	Ammo:	Training Practice Armor Piercing Incendiary High Explosive Incendiary
Weight:	1850 lb Loaded 1470 lb Empty (Fire Out)		
Firing Rate:	2400 Rounds/min	Reliability:	15,000 MRBS
Capacity:	353 Rounds		



30mm Gun Pod



Recoil Adapters

Ammunition Lead

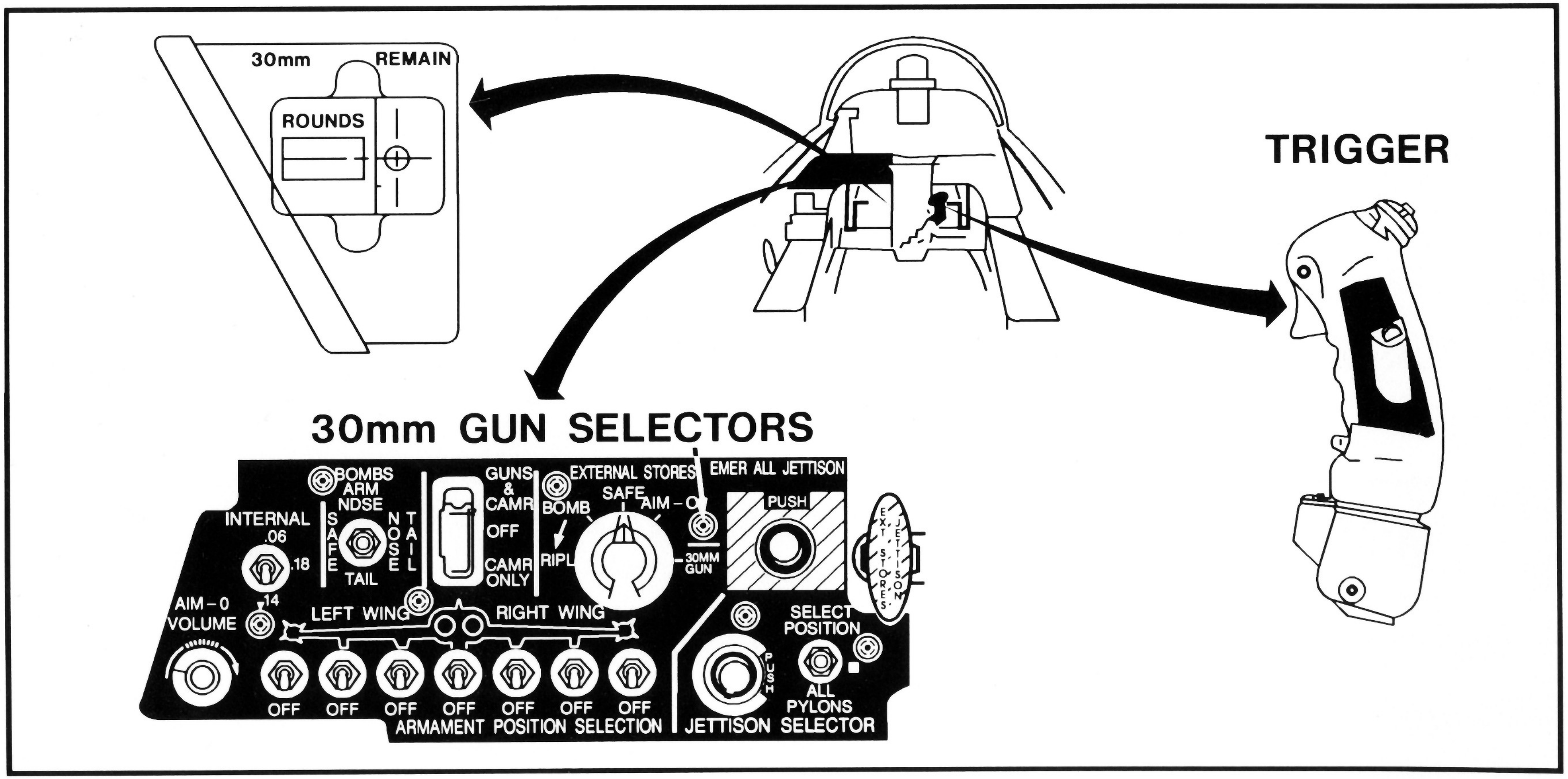
Strongback

Pneumatic Drive

GE430 Gun

Gas Deflector/
Muzzle Brake

30mm GUN POD CONTROLS AND INDICATORS



TRIGGER

30mm GUN SELECTORS

30mm
REMAIN
ROUNDS
BOMBS
ARM
NDSE
SAFE
NOSE
TAIL
TAIL
INTERNAL
.06
.18
.14
GUNS & CAMR
OFF
CAMR ONLY
EXTERNAL STORES
BOMB
SAFE
AIM-O
RIPL
30MM GUN
EMER ALL JETTISON
PUSH
EXT. STORES JETTISON
AIM-O VOLUME
LEFT WING
RIGHT WING
OFF
OFF
OFF
OFF
OFF
OFF
OFF
ARMAMENT POSITION SELECTION
PUSH
SELECT POSITION
ALL PYLONS
JETTISON SELECTOR

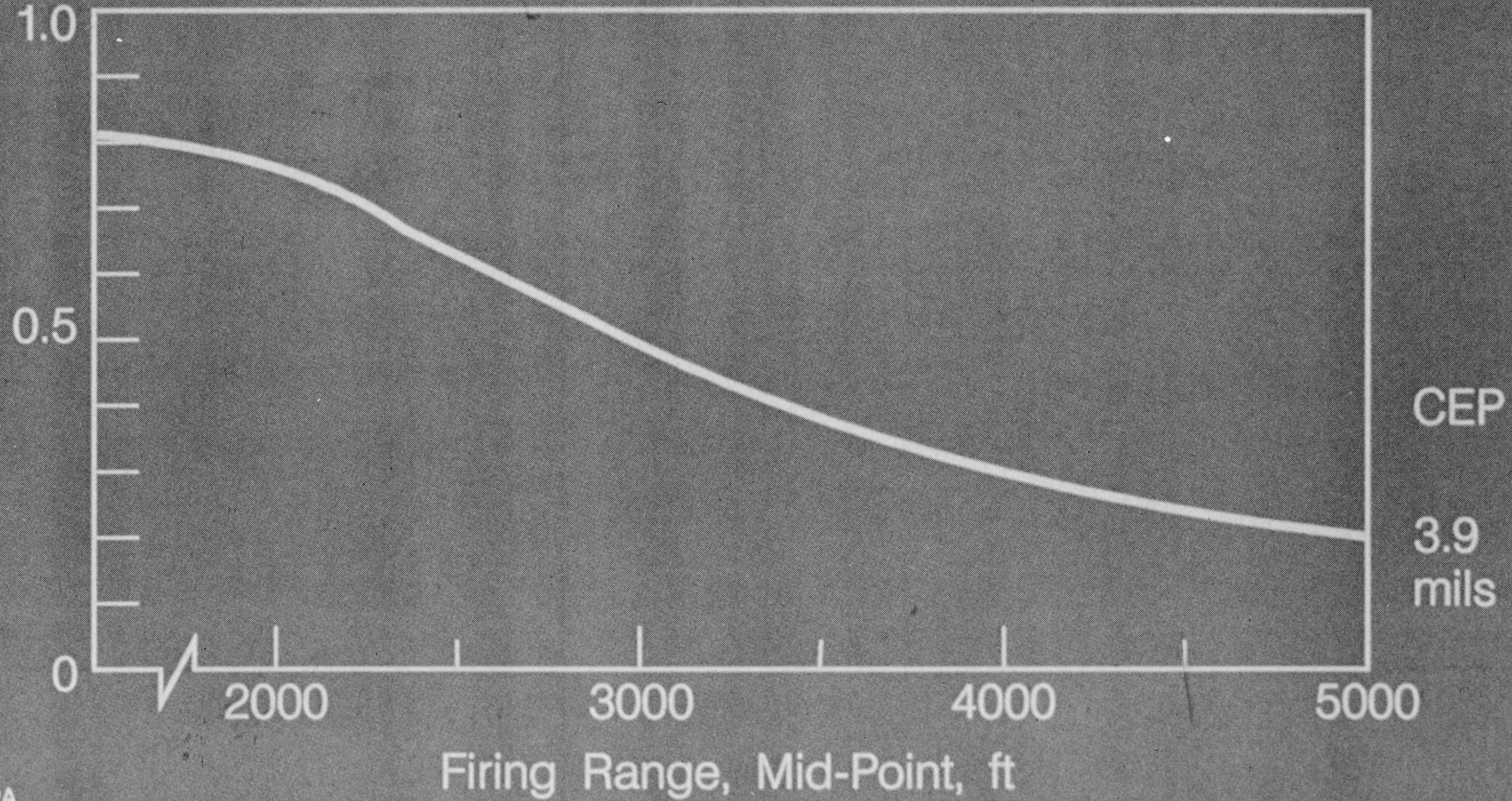
F-5E WITH 30mm GUN POD

INTERFACE REQUIREMENTS

- NEW DEDICATED PYLON WITH MODIFIED MAU-40 BOMB RACK
- FUSELAGE STRUCTURAL MODIFICATION AT ℄ PYLON
- ELECTRICAL AND COCKPIT MODIFICATION
- EXISTING BORESIGHT TARGET MODIFICATION

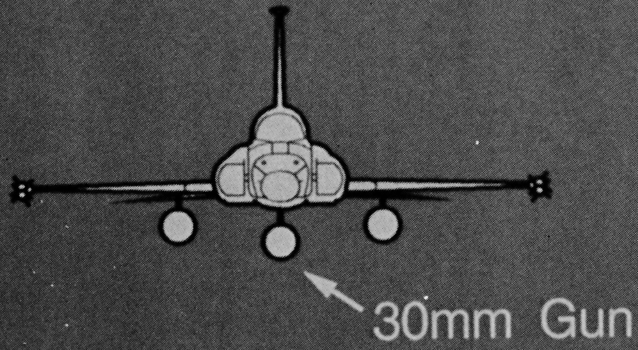
Single-Burst Probability of Tank Kill (P_{TK})

P_{TK} With (1) 1.5-sec Burst (55 Rounds)



86−0162A
4A I

30mm Gun Pod Missions

Configuration (2) AIM-9 (2) 275-gal Tanks	150 NM Radius Close Air Support		Interdiction Radius ~ NM	
	Loiter ~ min	Combat ~ min	H-L-H	L-L-L
	45	6	345	245

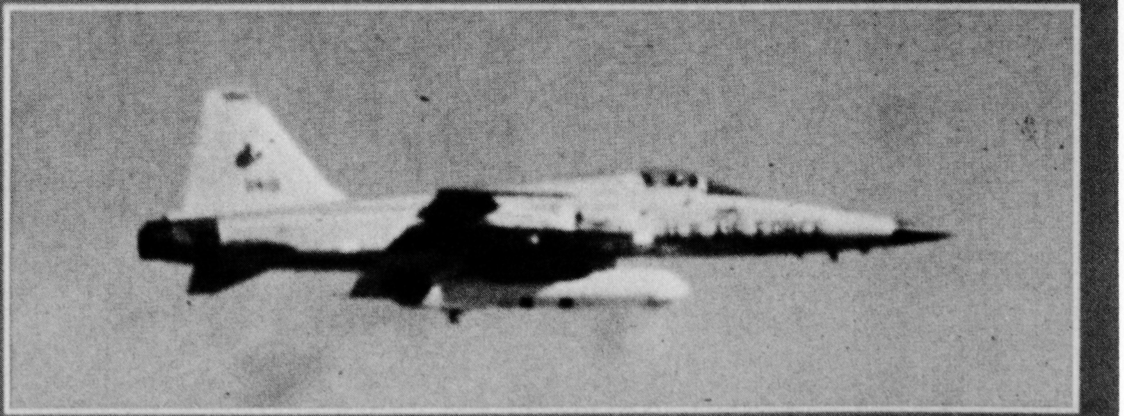
F-5E Qualified for 30mm Gun Pod

F-5E/GPU-5/A – March 1979

- Demonstrated Accuracy Against 20 ft x 20 ft Panel Target
- Achieved Overall Accuracy of 3.9 mils

Program Status

- Operating on Thai F-5Es
- Demonstrated in Korea



79-01346

30mm Gun Pod Operational Benefits

- Most Cost-Effective Tank Killer
- Effective Against Most Mobile Targets
- Ideal Targets-of-Opportunity Weapon
- Multiple Targets Per Sortie
- Low Tracking Time-Reduced Vulnerability
- Affordable Training and Wartime Cost

Tigerclaws

New 20mm Cannon

Improvements

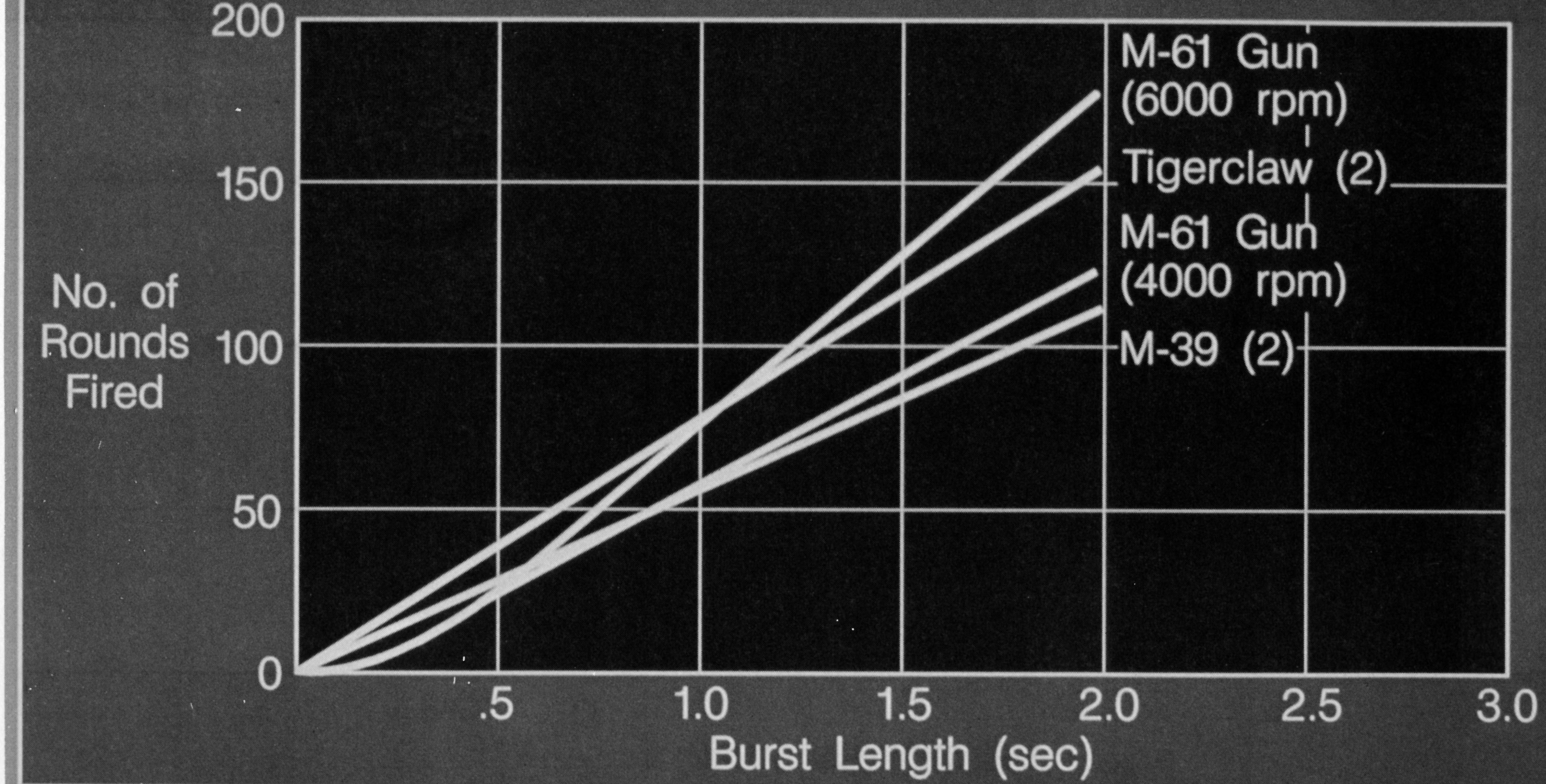
- Reliability
  - Improve Parts Fit (Dimension and Tolerances Changes)
  - Change metals and Heat Treat
  - New Seal and Spring Designs
- Firing Rate
  - Reduced Slide Stroke 1-1/2 Inches/Cycle
  - Decrease Slide Weight
    - Changed Parts Affecting Firing Rate From Steel to Titanium

Tigerclaws

New 20mm Cannon

Parameter	M39A3	Tigerclaw	Percent Improvement
Weight (lb)	178	136	23.5%
Firing Rate (RDS/min) 2 Guns	3000	4600	53.3%
Reliability (MRBF)			
Gun	3530	4620	30.9%
System	2000	3500	75%
Charging System	Mechanical	Pneumatic	–

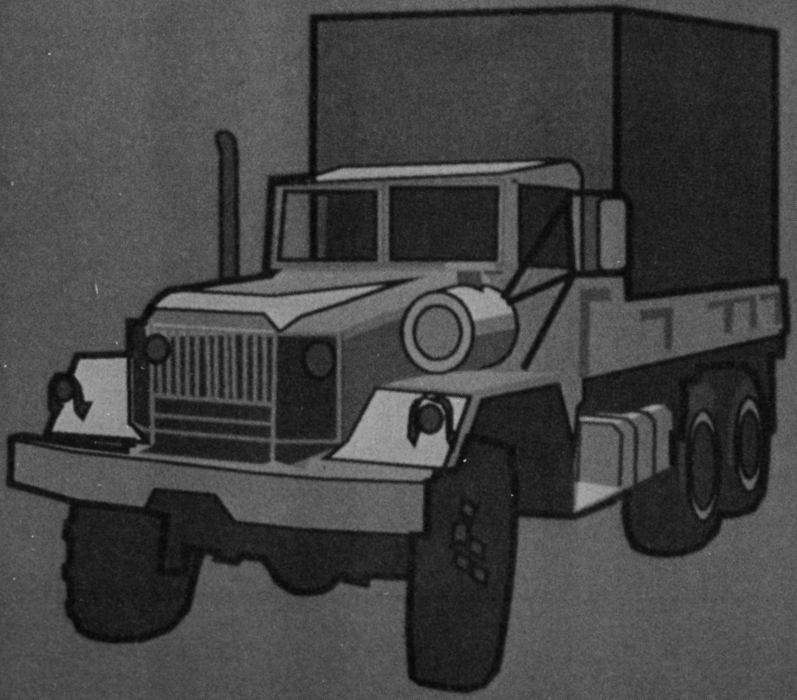
Rounds per Burst Length Comparison

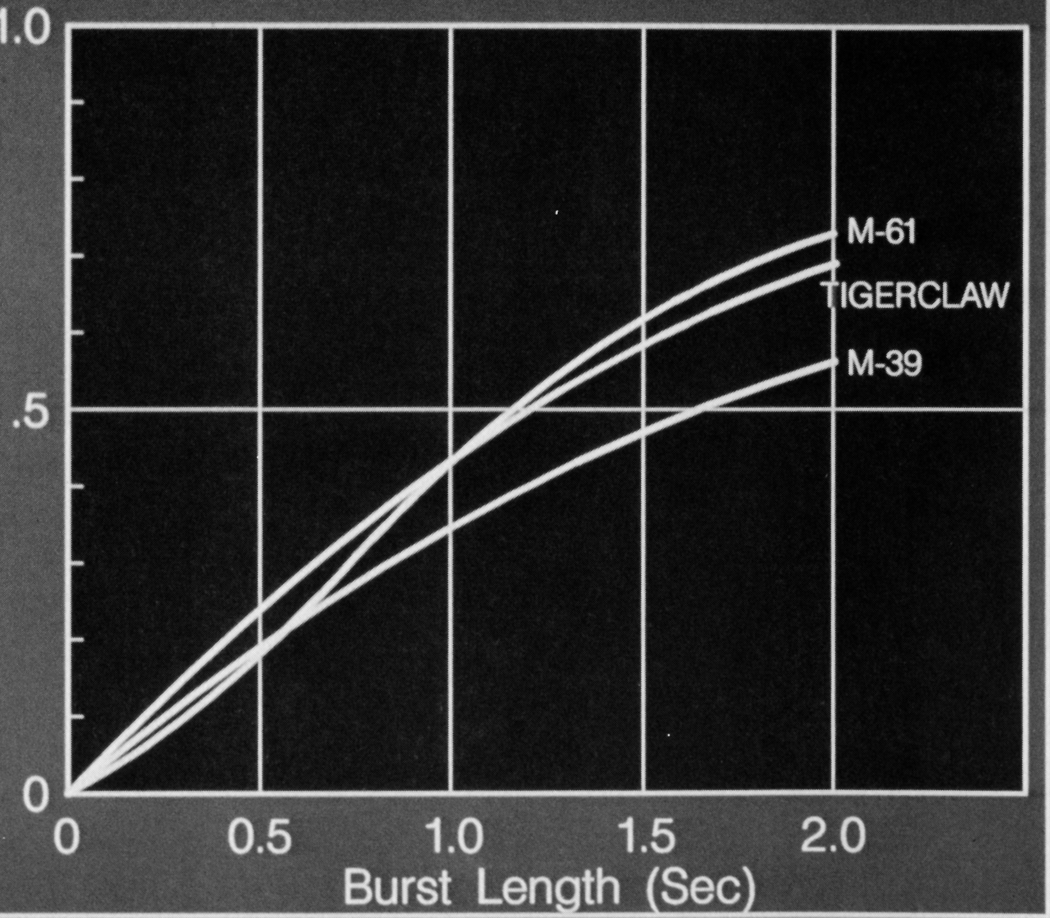


Probability of Kill (P_K)

Air-to-Surface

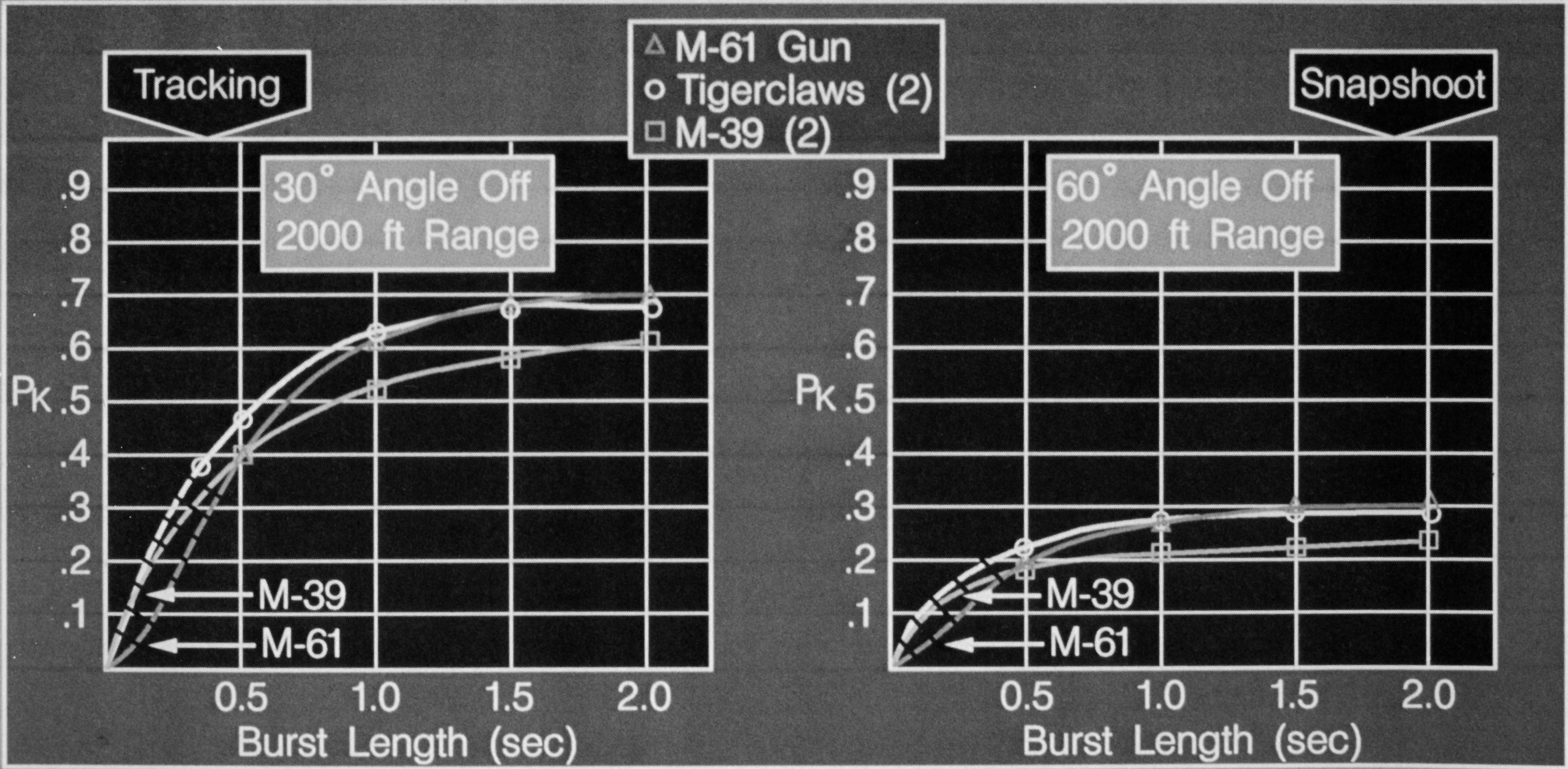
Ground Target
(Military Type Truck)





Probability of Kill (P_K)

Air-to-Air



Technology Enhancements

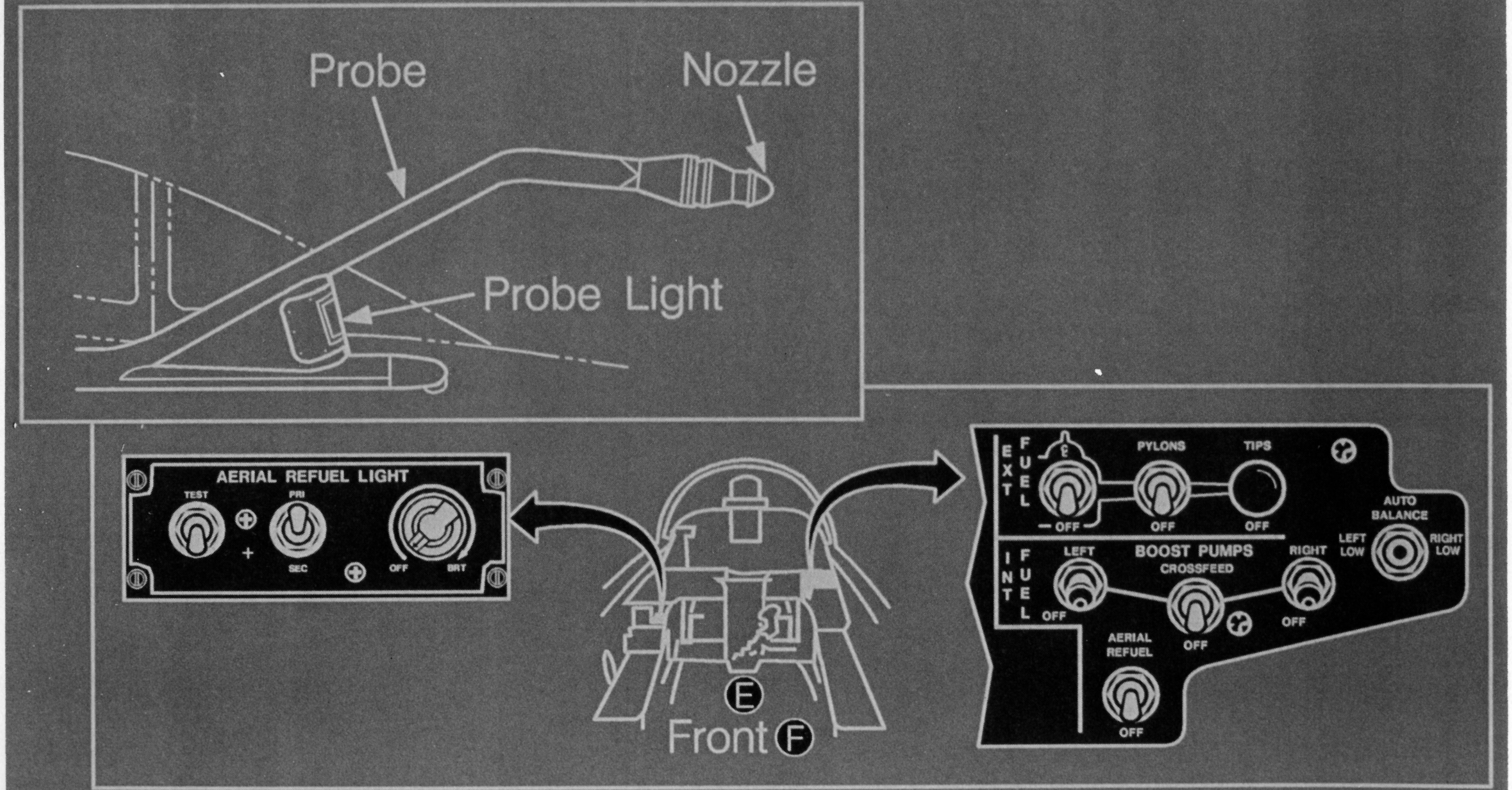
- HUD/Weapons Delivery Computer
- HUD/Weapons Delivery Computer/INS
- Laser Ranger
- Multimode Radar
- Defensive Systems
- Weapons
- Air Refueling
- Program Plan
- Summary

Aerial Refueling

- Increased Range, Payload/Radius
- Extended Deployment Range
- Increased Loiter, Time on Target, and Training Duration

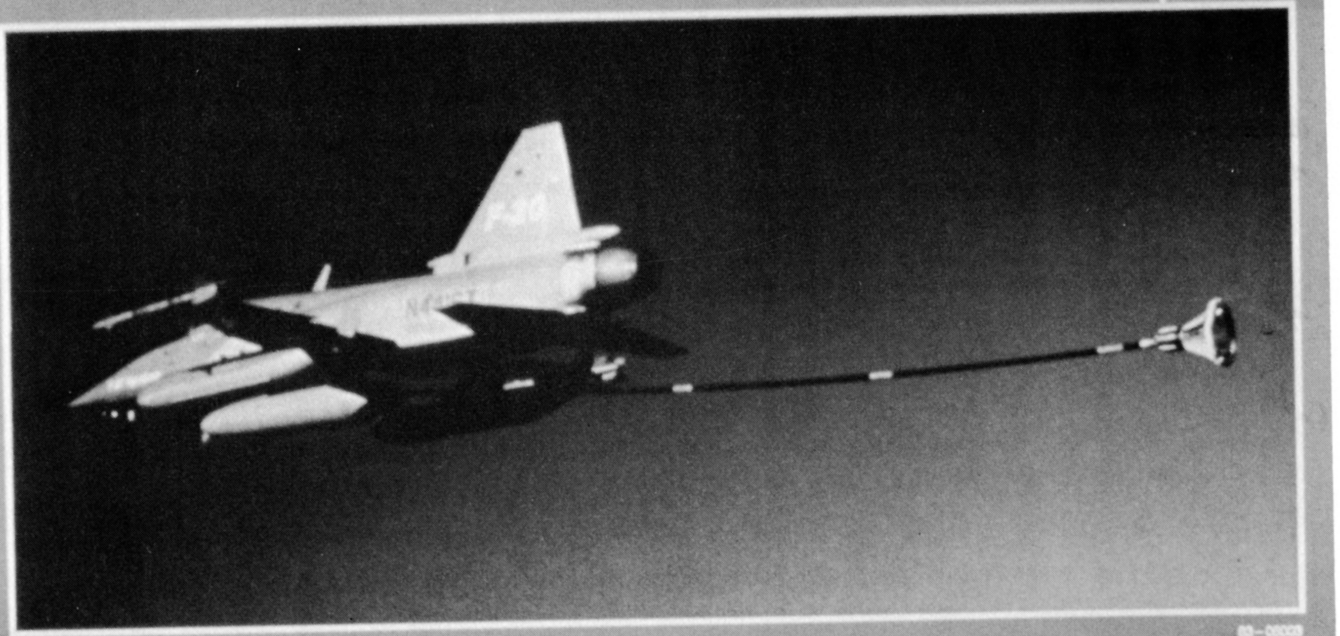
74-00093

Aerial Refueling Installation

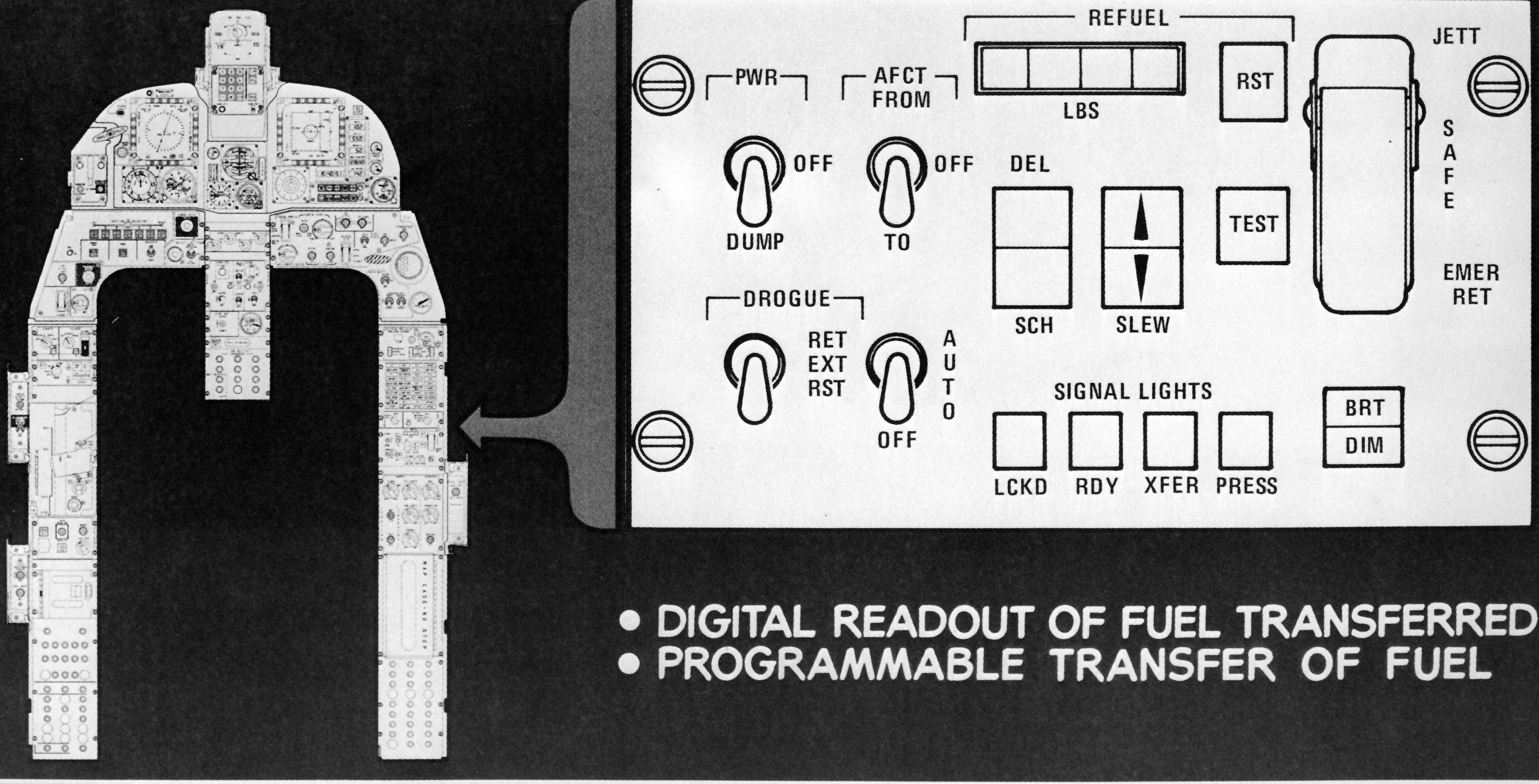

Probe
Nozzle
Probe Light
AERIAL REFUEL LIGHT
TEST
PRI
SEC
OFF
BRT
E
Front F
EXT FUEL
PYLONS
TIPS
OFF
OFF
OFF
AUTO BALANCE
LEFT LOW
RIGHT LOW
INT FUEL
LEFT
BOOST PUMPS
CROSSFEED
RIGHT
OFF
OFF
OFF
AERIAL REFUEL
OFF

Tactical Aerial Refueling Store

- Flexible Force Projection
- Refueling Integral With Fighter Squadron
- Survivable in Hostile Environment
- Flown on F-20A



F-20A AIR REFUELING SYSTEM
(COCKPIT)*

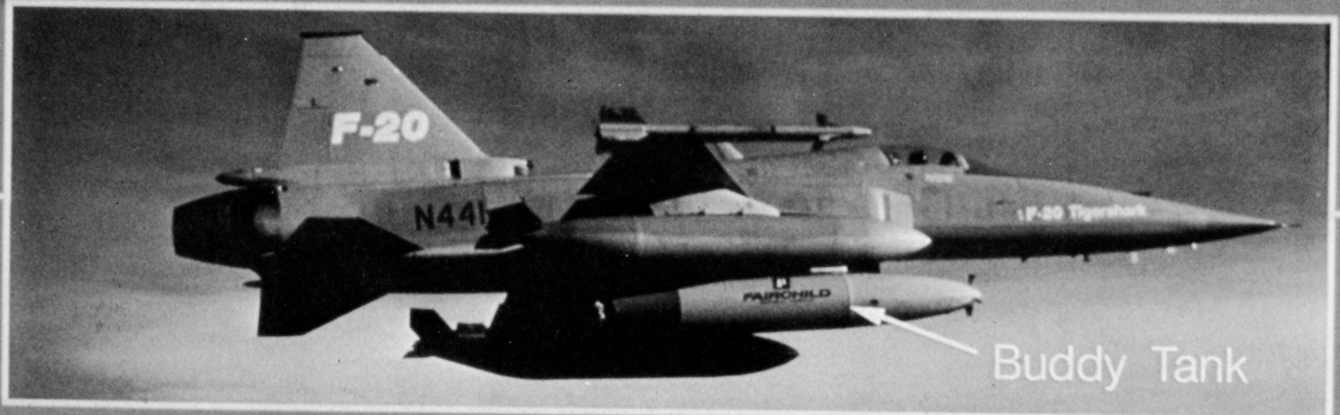

REFUEL
JETT
PWR
AFCT FROM
LBS
RST
OFF
OFF
DEL
SAFE
DUMP
TO
TEST
EMER RET
DROGUE
RET
EXT
RST
AUTO
OFF
SCH
SLEW
SIGNAL LIGHTS
BRT
DIM
LCKD
RDY
XFER
PRESS

- DIGITAL READOUT OF FUEL TRANSFERRED
- PROGRAMMABLE TRANSFER OF FUEL

* REPRESENTATIVE DESCRIPTION-VENDOR SELECTION PENDING

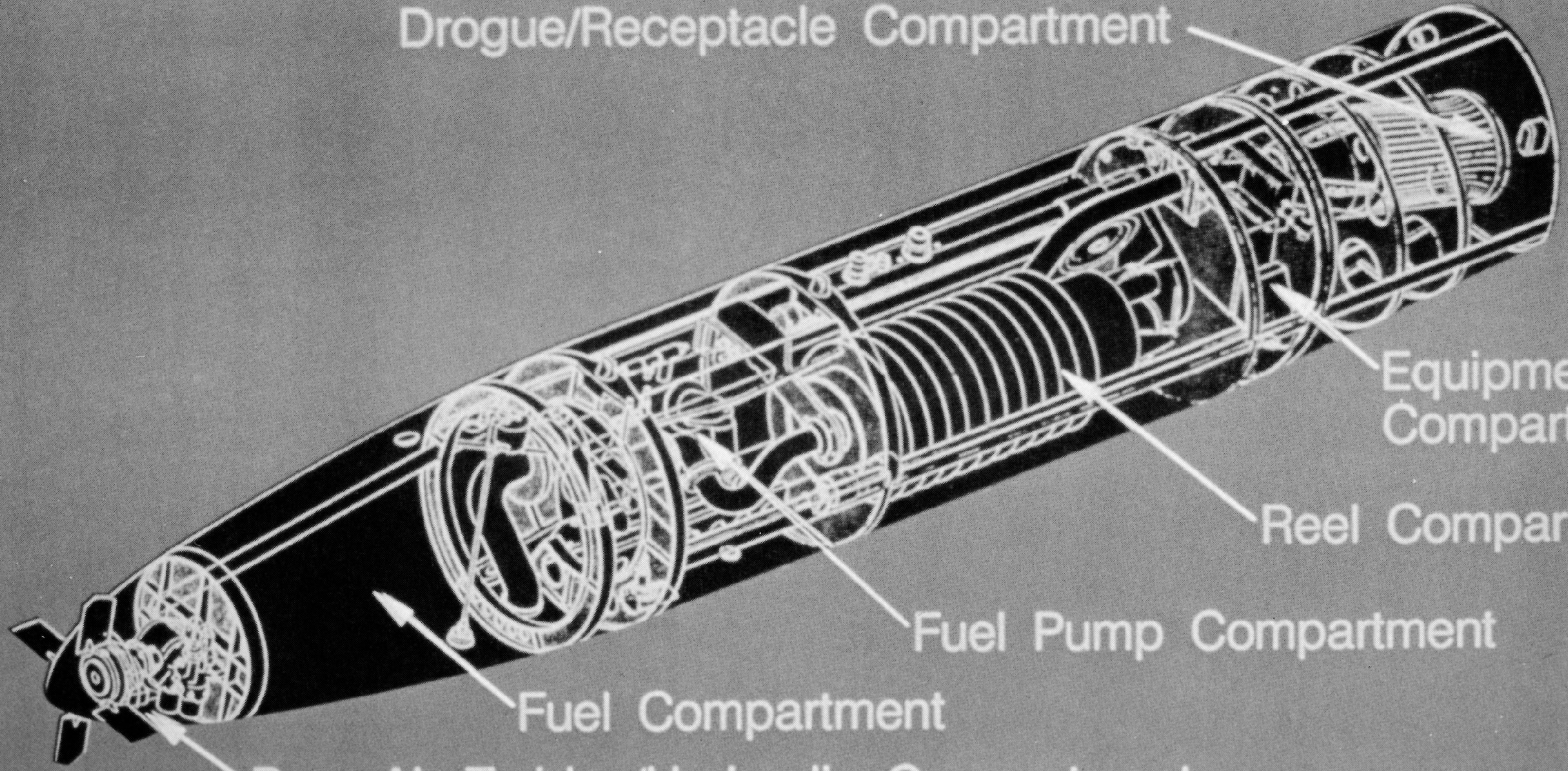
System Description

- Centerline Mounted, Self-Powered, Fully Automatic
- 300 Gallon Fuel Capacity in Refueling Store
  - Transfer Rate 200-400 gpm
  - Total Fuel Transfer as High as 8,000 lb Depending on Radius
- Refueling Envelope Is Sea Level to 35,000 ft, 200-325 kt
- 4.0 g Full and 6.0 g Empty, "V" Max With Hose Stowed


F-20
N441
F-20 Tigershark
FAIRCHILD
Buddy Tank

83-06007

Aerial Refueling System



Drogue/Receptacle Compartment

Equipment Compartment

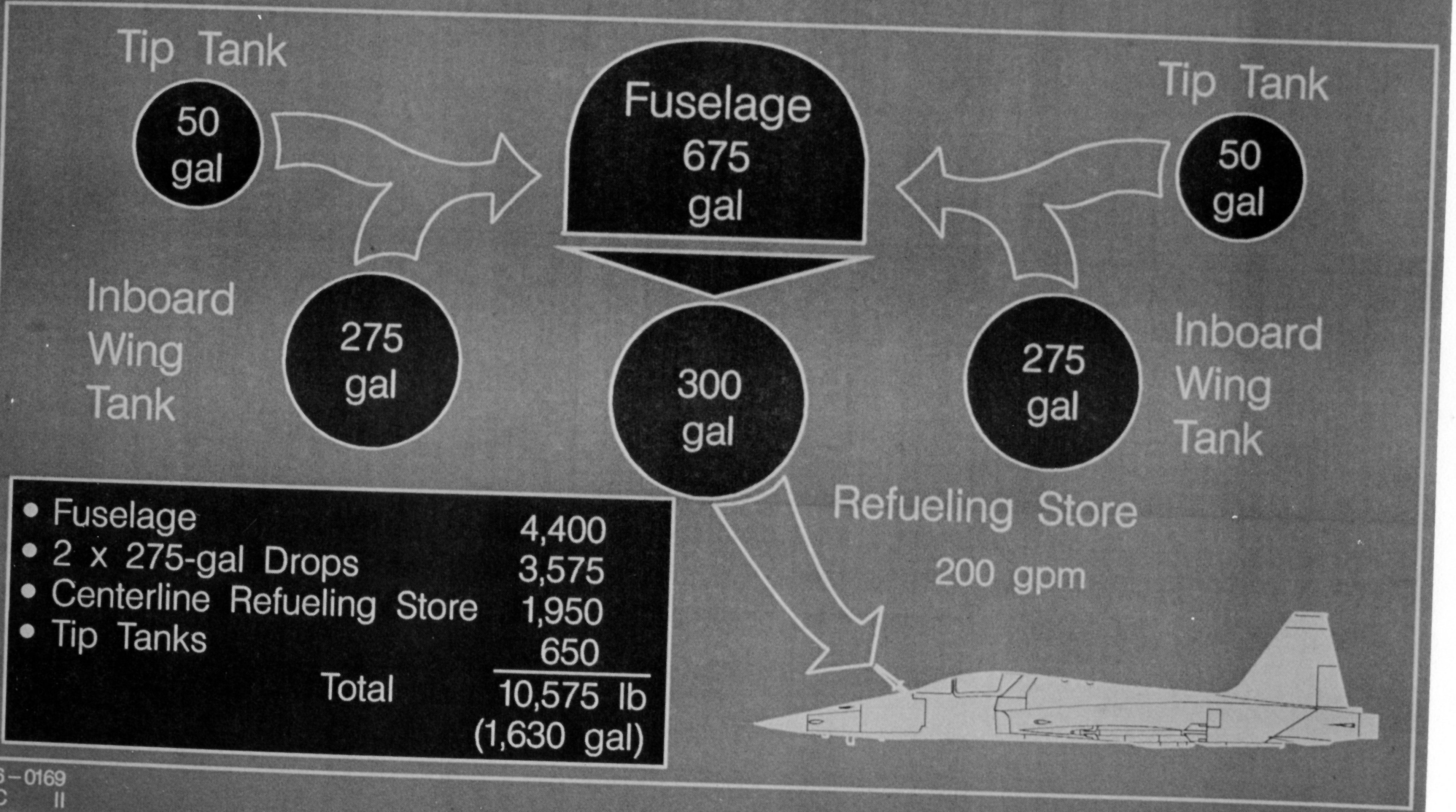
Reel Compartment

Fuel Pump Compartment

Fuel Compartment

Ram Air Turbine/Hydraulic Compartment

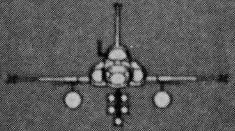
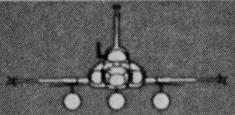
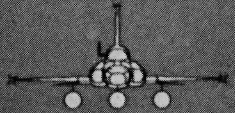
F-5E Aerial Refueling System


Tip Tank
50 gal
Fuselage 675 gal
Tip Tank
50 gal
Inboard Wing Tank
275 gal
300 gal
275 gal
Inboard Wing Tank
Refueling Store
200 gpm

• Fuselage	4,400
• 2 x 275-gal Drops	3,575
• Centerline Refueling Store	1,950
• Tip Tanks	650
Total	10,575 lb (1,630 gal)

86 – 0169
3C II

Refueled Mission Performance

Mission	Configuration	Unrefueled Radius, NM	Refueled Radius, NM
Hi-Lo-Hi Interdiction	 (2) AIM-9 (5) MK-82 (2) 275-gal Tanks AR Probe	330	600
Combat Air Patrol	 (2) AIM-9 (3) 275-gal Tanks AR Probe	570	910
Ferry Range	 (2) AIM-9 (3) 275-gal Tanks AR Probe	1275	1860

Tanker Configuration: (2) 50-gal Tip Tanks
(2) 275-gal Tanks
(1) 300-gal Buddy Tank

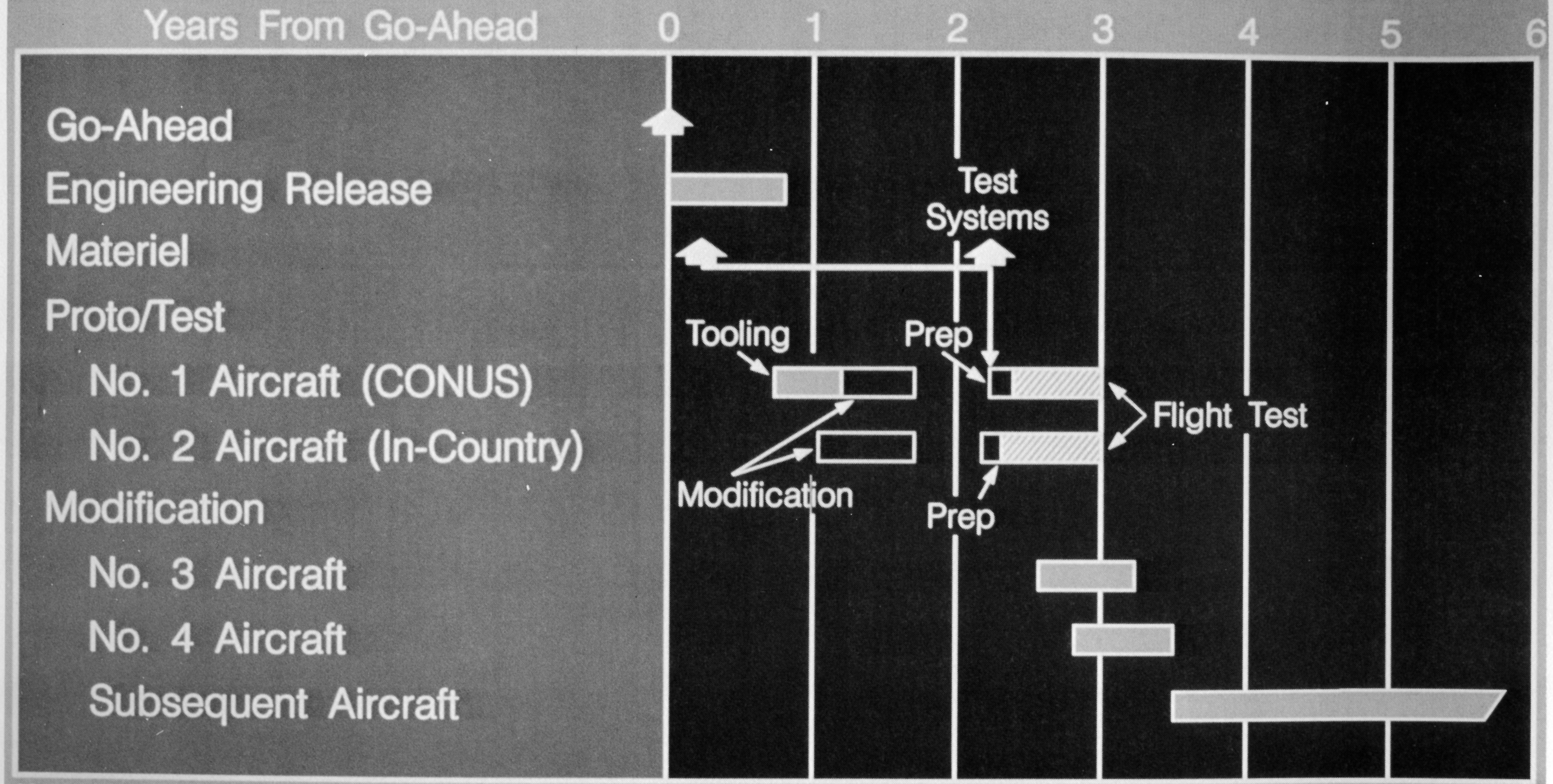
F-5E Tactical Tanker Summary

- Provides Extended Force Projection Capability
- Increases Deployment Range of Tactical Aircraft
- Increases Overall Mission Capability
  - Low Cost
  - Versatile
- Increases Loiter Time/Distance In/To Target, Training and Operational Areas
- Tanking Inherent to Fighter Squadron
- Rapid Conversion of Tanker to Combat Role
- Provides Tanking in Safety/Emergency Situations

Technology Enhancements

- HUD/Weapons Delivery Computer
- HUD/Weapons Delivery Computer/INS
- Laser Ranger
- Multimode Radar
- Defensive Systems
- Weapons
- Air Refueling
- **Program Plan**
- Summary

F-5E Avionics Update With Radar



86-0179B
5C I

Groundrules and Assumptions

- Planning Purpose Estimates
- 1986 Dollars
- Recurring Cost, per Aircraft
  - Equipment Unit Cost
  - Aircraft Installation Hardware
  - Aircraft Modification
  - Documentation
- Spares, Maintenance Training, and Support Equipment Excluded
- Northrop Will Modify First 2 Aircraft and Will Train Personnel To Modify Aircraft 3 and Subsequent Aircraft
- Baseline Configuration and Selected Option(s) Are Accomplished Concurrently

Planning Purpose Estimates

Millions of USA $

Configuration	Estimate
HUD/WDC/INS	0.8-0.9
HUD/WDC/INS Plus Laser Ranger	1.0-1.2
HUD/WDC/INS Plus Multimode Radar	2.0-2.5

86–0187
2E I

Planning Purpose Estimates

Thousands of USA $

Option	Estimate
Radar Warning Receiver (ALR-46)	300
Chaff/Flare Dispenser (ALE-40)	150
AIM-9P4 Sidewinder	100*
AGM-65 Maverick	200*
30mm Gun Pod (GPU-5/A)	700
In-Flight Refueling Probe	200
Tactical Aerial Refueling Store	200*

* Excludes Weapon/Store Costs

86–0188
2E I

Technology Enhancements

- HUD/Weapons Delivery Computer
- HUD/Weapons Delivery Computer/INS
- Laser Ranger
- Multimode Radar
- Defensive Systems
- Weapons
- Air Refueling
- Program Plan
- **Summary**

Summary

- F-5 Is a Capable, Reliable, Maintainable Aircraft With a Long Remaining Useful Life
- F-5 Enhancement Will Provide Effective Future Combat Capability:
  - Weapons Delivery at Highest Attainable Accuracy
  - Significant Expansion in Air-to-Air Capability
  - Improved Survivability
  - Greater Weapons Flexibility
  - Improved Range, Force Projection
- Program Plan Provides:
  - Affordable Cost
  - Minimum Schedule
  - Maximum In-Country Participation

NORTHROP

Aircraft Division
Aircraft Group

Northrop Corporation

One Northrop Avenue
Hawthorne, California 90250